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GEOGRAPHY AS A SCIENCE IN ENGLAND.

By HUGH ROBERT MILL, D.Sc.

GEOGRAPHY, as a science, has not flourished in Great Britain. Men may be found in our Universities and learned Societies who sneer at the pretensions of geography to scientific rank; and, when the phrase "Principles of Geography" has been employed, cultured professors have smiled at it as at a paradox. "Geography," remarked a classical scholar to me not long ago, "if a science, is of no educational value; there is only one science which is possibly more barren and profitless to the student—the science of heraldry." The claims of geography as an element in education are, however, being ably urged by powerful voices, and, if not yet fully realised, they are likely to be widely conceded before many years go by. With geography in education I propose to have nothing here to do, except, it may be, incidentally; for in proportion as geography attains recognition in University education will the special subject of this article gain importance and compel attention.

Geography as a science is not respected because it is not understood; and the ground of the misunderstanding, in some cases at least, is that "a science" is not uncommonly looked upon as a department of specialised knowledge. Starting with this idea, it is perfectly logical for an objector to say that the ground claimed for geography is covered by the sciences of astronomy, geodesy, geology, oceanography, meteorology, botany, zoology, history, and anthropology—if, as is not likely, he allows that the last-named are sciences—and to declare that there is no room for the "science of geography." I contend that the departments of natural knowledge cannot be so "clean cut from out and off the illimitable" as to admit of their being arranged side by side to cover the field of nature like a tesselated pavement. Each one is, to a greater or less extent, permeated by those surrounding, and permeates them in turn: the astronomer is not independent of the chemist nor the meteorologist of the astronomer. If sciences are to be viewed as *tesseræ*, the "sciences" as at present familiarly classified must be analysed into units of profound specialism, each of which may be a single and independent study, and may be utilised, differently combined, in neighbouring "sciences."

We may, then, view "a science" as composed of a group of specialisations, a molecule compounded of atoms, so that the same atoms of ultimate specialisation may be combined successively in different molecular generalisations. Another step carries us to the recognition of sciences of higher generalisation, in which the units are the "molecular" sciences themselves, combined and subordinated to a new yet special purpose. It is easy enough to recognise physics as capable of analysis into mathematics and the sciences of matter and energy—heat, light, electricity, and so on; yet he would be accounted a student of little perception who should deny the claim of physics to be a science because the ground is already covered with heat, light, and the rest. It is only in unfamiliar paths that scientific men "cannot see the wood for trees."

My claim is that geography as a science is so far akin to physics that it is a generalisation of the second order, a natural grouping of units which are individually distinct. The physicist looks on nature in the universal aspects of matter and energy; the geographer looks on nature in the limited, but still general, aspect of the surface of the earth.

Geography as a science is the exact and organised knowledge of the distribution of phenomena on the surface of the earth. This involves the human race; and because the human race represents the culmination of organic evolution, the true understanding of the interaction of man with his terrestrial environment is the final object of geography. The materials for building up the final generalising science fit to fulfil such an aim are yet far from complete; but they are already outlined with sufficient clearness to allow of progress being made in the general study. Incompleteness of data is the best incentive to progress and the surest guarantee of substantial advance.

Chemistry was a science even in the days when the professor spoke profoundly of calces and phlogiston; and it was precisely because he generalised his scanty data, and strove to verify his generalisations by renewed observations, that the era of oxygen ushered in the atomic theory with a brilliance that has shrined the fame of chemistry as science *par excellence* in many a humble mind to-day. Yet, before the atomic theory and the periodic law existed to unify the early facts, these had been studied and the principles connecting them groped for. In the time of this groping, chemistry was not the educational machine it has since become, and the products of its study were, for many years, rather amusing experiments than industrial advances. That incomplete data do not retard the growth of theory is proved by modern chemistry, which started from a knowledge of the elements of air; but although argon eluded Cavendish the growth of chemistry was unchecked, and the advancing theory ultimately suggested elements the discovery of which could hardly have been imagined otherwise. In other words, the facts and the theory of a science assist each other, and are best developed simultaneously.

Geography, if properly studied and allowed its natural growth as a science, is now, in the opinion of geographers, as sure to grow and to lead to theoretical generalisations and applications of economic values as chemistry was in the days of Davy.

I have already on several occasions endeavoured to give expression to my views of the content of geography as a science,* and need only quote here the opinion that the ultimate aim of geography is "the elucidation of the earth viewed as the present expression of a definite evolution, in which every part is subordinated to the production of a suitable home and sphere of influence for civilised man." The way to attain this end is obviously to proceed toward the completion of our knowledge of all the phenomena the interaction of which is in question, aided by such principles and relationships as can be deduced from what is already known.

The astronomer, geologist, oceanographer, meteorologist, botanist, zoologist, anthropologist, and historian are all laid under contribution in different and varying degree to supply the building material for the geographer to combine, according to his special view-point, into a generalised science, capable of endless application to the sciences which helped to form it, and to the affairs of daily life. A large part may be taken in advancing a science without the individual specialists realising the full import of their contributions, and comparatively few great travellers and explorers were consciously geographers. In considering the position of scientific geography it is convenient to distinguish between detailed exploration and research recorded for convenience by various adaptations of cartographic art, and the discussion and co-ordination of the relations which exist between the various special elements; to distinguish, in fact, between the collection and the interpretation of facts.

It would be absurd in these days of international congresses to speak of any science as being the province of any nation or class, yet there is an influence of race and language upon thought which, however imperfectly it may be understood, is not to be ignored in any science. People of different race work by different methods and pursue different ideals; and it will probably be found that the nation in which any science has developed most rapidly in its adolescent period strongly impresses its particular individuality upon the science, although the impress may subsequently be obscured as contributions accumulate from other sources.

In some languages—German, for instance—it is easier to make and use new terms for new ideas than it is in English. And in its present period of rapid growth geography as a science seems likely to be very largely, if not mainly, advanced by German generalisers, just as chemistry at a similar period in its history was advanced by French specialists. Our chemical terminology was originally a direct transference of the French words, modified according to natural and simple rules. Our geographical terminology may very likely show the German stamp, although it is as yet in an unorganised and rudimentary condition, needing much carefnl weeding and cultivation to make it a fit medium for conveying the ideas of the science. The terms of mathematical geography are for the most part Latin or Greek in origin, but new terms for descriptive purposes are spreading rapidly from the German into all modern languages. For example, the opposite idea to watershed—itself a Teutonic form—is only expressed by *Thalweg*, which denotes the line of the meeting of waters from converging slopes. *Hinterland* has also been naturalized, directly to express concisely an idea for which the only possible English expression involves several words. Geography suffers from the want of terms, and in America many are being introduced from Greek, Latin, and mongrel sources, some of which will survive. The language which lends itself to self-explanatory terms which every speaker of it understands at the first hearing, such as *Höhlenkunde* and *Seenkunde*, must always have an advantage as a vehicle for rapid interchange of new thought over one which is obliged to fall back on alien origins for *Spelæology* and *Limnology*, which even specialists require to ponder over before they realize that they mean Cave-knowledge and Lake-knowledge.

It will probably be disputed by few that the greatest explorers for the last two hundred years have been British, while the greatest geographers, in the sense of scientific generalisers, have been German. This can be said without in any way detracting from the brilliant explorations which from time to time have been carried out, and the important generalisations that have been arrived at by people of every civilised nation. But in geography the aptitude of British workers has been towards the collection, and not the discussion, of facts.

One may search long for notices of theoretical geography in such memoirs as Mr. Clements Markham's "Fifty Years' Work of the Royal Geographical Society," or the "Review of British Geographical Work during the Last Hundred Years (1789-1889)," prepared by him and Mr. Scott Keltie for the Paris Exhibition of 1889; or in Mr. Silva White's "Achievements of Scotsmen during the Nineteenth Century in the Fields of Geographical Exploration and Research," prepared for the same occasion. But these compendia record the accumulation of geographical data from every part of the earth as yet accessible to man, a mass of solid work it does one good to think of. No maps rival those of the Ordnance Survey of the United Kingdom either for accuracy of survey or beauty of execution; no charts show so fully the configuration of the sea-bed round every coast in the world as those of the British Admiralty; the Great Trigonometrical Survey of India is a work of unparalleled grandeur. It would be endless to dwell upon the doings of British travellers in every continent and over every sea which have resulted in thousands of conscientious observations of astronomically fixed positions, and information of every sort which a traveller can possibly accumulate. The frozen seas of the North and the South have been penetrated farther and more frequently by British keels than by those of any other nation. The circumnavigations of Cook and of his followers in British surveying ships, the epoch-making voyage of the *Beagle*, and the culminating glory of the *Challenger* expedition are all just sources of national pride, and each was the occasion of garnering vast harvests of geographical facts. So far as the utilisation and interpretation of these facts are concerned, foreign nations have come before us. We have supplied them with the raw material; they return us the elaborated article stamped with the mark of Continental thought.

The English language is rich in the records of voyages; and the collections of early travels prepared by Hakluyt and Purchas show that bent toward the treatment of geography as exploration which has come to be distinctive of our modern work, contrasting with the typically French conception of geography as history and politics, and the German academic treatment of the theme. In the eighteenth century the Royal Society was frequently concerned with geographical questions, and its great president, Sir Joseph Banks, the companion of Captain James Cook, might, but for the multifarious interests of his active mind, have rivalled Humboldt as an interpreter as well as an investigator of geographical phenomena. His contemporary, Rennell, whom

* See "The Realm of Nature" (London: John Murray); also "The Principles of Geography" in the *Scottish Geographical Magazine* for February, 1892; and "The Geographical Work of the Future" in the same journal for February, 1895.

Mr. Markham hails as the greatest English geographer, did much to bring the methods of scientific criticism to bear on the discussion of the observations of travellers; and from his own early training in the practical work of surveying, his theorising was sobered by a knowledge of the limitations of methods of observation and delineation. Rennell found no successor to continue his masterly handling of the divers strands of geographical science. Men like Rawlinson, Bunbury, Yule, and Freeman followed him in researches into ancient and Oriental geography, piecing together the broken records of past knowledge in the light of geographical principles. Men like Arrowsmith and A. Keith Johnston raised practical cartography to the highest level it ever reached in this country; and the Ordnance Survey of the United Kingdom slowly produced the finest map which has ever been completed.

The Royal Geographical Society and the British Association, originating almost at the same time, have done much to advance and popularise geography in many forms; but even the former, despite great efforts from time to time by the inauguration of valuable lectures on scientific geography by specialists in different departments, has failed to ensure the continuous and systematic pursuit of geographical science. The disquieting feature, from a national point of view, is that our original part of pioneer exploration is almost played out. The Polar areas remain the only unexplored territories. Science must now in large measure take the place of mere pluck; the work of the explorer is giving way to that of the trained investigator, and the popular task of recording explorations must continue to give way to the more exacting labour of discussing investigations. It is in this direction that the great advances of geography in the immediate future will have to be made.

An illustration will give point to this statement, and show how much work lies surprisingly near our hands, yet waiting to be accomplished. If anyone wishes to study the geography of the British Islands he finds no treatise to guide him except some small school books, a few popular and unsystematic compilations of more size than substance, guide books designed for the sightseer, and gazetteers of value only for occasional reference. There is no scientific treatise on the subject, because no one has yet attempted to apply scientific geographical methods to the treatment of the abundant (though by no means complete) raw materials which have been collected, and may be unearthed by the diligent student.

The materials available are:—(1) The Ordnance Survey maps showing the whole surface of the United Kingdom on three scales of ample size; with two different styles of delineations of physical features on the smallest and most convenient scale. (2) The work of the Geological Survey, which has nearly completed a map of the kingdom showing, on the topography of the Ordnance Survey, the nature and structure of the underlying rocks, with evidence of the utmost value as to the distribution of economic minerals. (3) The Hydrographic Surveys of the Admiralty round the coasts, by which the submarine configuration is shown with great exactness, and the shifting features of moving sandbanks traced by periodical re-surveys. (4) The Census, taken decennially, which shows, for every registration district, a mass of statistics as to the number and nature of the population, their occupations, origin, and age. (5) The statistics of births, marriages, deaths, and migration, which serve, though as yet imperfectly, to bridge the long gaps between successive verifications by Census. (6) The Board of Trade returns as to commerce by sea and land, the movements of seaports, and the traffic of railways, showing how the life-blood of the country circulates through its arteries. These Government sources may be supplemented by statistics of climate which have been accumulated partly by the Meteorological Office, more largely by the Royal and the Scottish Meteorological Societies, and by the individual efforts of Mr. Symons for rainfall.

All of these supply data which are essentially distributional, and therefore amenable to the principles of geography for discussion and co-ordination; but they are not officially brought into unison. They remain the separate work of specialists, and one throws the minimum of light upon another. The Ordnance Survey, it is true, provides the topographical outlines on which the geological maps are constructed, and it supplies to the Census Office the outlines of the registration districts which accompany the Census reports. But the Ordnance Survey is itself undescribed. It exists in mere maps, to be turned over carelessly or curiously, and passed by, forgotten and unappreciated. It is only within the last few years that the maps have been completed by the addition of contour-lines of submarine slopes supplied by the Admiralty; although the Admiralty has always been indebted for the coast-lines, and such land features as are shown on the charts, to the Ordnance Survey.

The Admiralty charts are accompanied by official sailing directions which often go beyond the bare facts necessary for purposes of navigation, and give interesting scraps of information as to the bordering land. The Geological Survey also has its memoirs, setting forth for every sheet of the map the details which have been ascertained by the geological surveyors, with theories suggested by the observations, and now and then a good deal of physical geography. In a few instances, such as Topley's "Memoir on the Weald," the work includes a true geographical treatise, tracing the relations of human institutions to the physical character of the ground, and explaining village sites and parish boundaries by reference to the escarpments and dip of the strata. The official Census and Board of Trade reports are extremely elaborate, but their treatment is rather statistical than distributional. All the meteorological data have been treated cartographically and discussed by the societies collecting them.

Only the Ordnance Survey remains without an official description. A memoir to the Survey was commenced for Ireland, but at the commencement it stopped. The data on the various sheets of the map are discussed nowhere, and the scores of interesting features which appear have only received passing notice from chance geologists. I should like to see, and would gladly help to make, a handbook or descriptive pamphlet of every sheet of the one-inch map. This should show the relation of the 216 square miles (432 square miles for the Scottish map) comprised in it, to the great natural features of the country, and then go on to describe the special features of the sheet. It would state the area between the various intervals of altitude, describe the river systems with their associated lakes (if any), and the structure of the valleys, the lines of communication, roads, railways, or canals, with the reasons for them. The sites of towns and villages would be treated so as to throw light on their origin; the distribution of scattered farms, country houses, and cottages would be handled so as to explain the distribution of population. County and parish boundaries would be discussed historically, so far as the vanishing evidence admits, in order to account for the eccentricities of outline and detached areas. The place names would be considered philologically, and grouped so as to throw light on early movements.

No such description could be complete without introducing explanatory facts drawn from the geological, meteorological, and statistical memoirs available; and, in many instances, historical events which are inextricably linked with the locality would be introduced. These would, however, be strictly subordinated in the plan, and nothing should be

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admitted in the description which did not directly throw light on the structure of the country, or which was not a direct outcome of the action of geographical conditions. Great engineering works which have changed the natural lines of communication of a district would of course be noticed, as well as the economic resources of the country. The whole would conclude with an alphabetical index containing every name on the sheet, with the latitude, longitude, and elevation of all important points.

This would form, if properly carried out, the greatest geographical work of the coming century, and would be completed by a discussion according to natural districts, such as Wales, the Pennine Chain, the Lake District, the Weald, the Fens. Afterwards these could be digested into an authoritative geography of the whole country, written with a perfect unity of plan and aim, and embodying the practical application of the principles of geography.

The preparation of such an ideal work would involve a great amount of geographical research, and would afford an opportunity for founding a school of British geographers, who would study their science practically and at first hand. The conditions of all research are the same. Abstraction on the part of the worker from all but the one aim being pursued is essential, and adequate training in the methods to be employed is necessary before beginning permanent work. These conditions are inconsistent with earning a living by doing work which is demanded by the public. The public does not yet realise either the value or the essential conditions of research. Practically, only a University professorship, in which research is the main object and lecturing is subordinate, would meet the case, unless a man of private means took the matter up, or it were undertaken under Government. Such work, to be efficient, would require to be steady, continuous, and unfettered. The results could not be sensational, and, very probably, would not be popularly appreciated; but participation in such research would be a noble training for students who do not desire to become specialists, for no educative influence is so powerful as personal association with a professor engaged enthusiastically in scientific work involving research in which every student may help.

I have enlarged upon a single instance, not because it is the only one that might be adduced, but because it may serve to suggest to those who have not thought of the matter before what sort of science geography is, what it may become, and how the impress of British thought may yet accompany the record of British work in the scientific literature of all nations.

THE GREAT RED SPOT ON JUPITER.

By E. WALTER MAUNDER, F.R.A.S.

OF all our planetary neighbours, Jupiter, the easiest to study, offers us the most numerous problems. First of all comes the striking contrast between its enormous mass and low density; next, there is the difficulty of understanding how its atmosphere can have the great depth which it evidently possesses without the lower layers becoming compressed to more than metallic density; thirdly, the great variety in the rotation period of the different markings of the planet; fourthly, the continual changes which the details of the apparent surface present; fifthly, a certain strong persistency about the planet's appearance as a whole; and lastly, summing in itself every variety of enigma, there is the great red spot.

Its history is sufficiently well known. Public attention here in England was first drawn to it by Mr. F. C. Dennett, who stated in the *English Mechanic* of November 22nd, 1878, that he had then had it under observation for fully four months. But other observers had had it in view long before this notice appeared. M. Niesten, at Brussels; Prof. Pritchett, at Glasgow, Missouri, U.S.A; M. Trouvelot, at Cambridge, Mass.; the observers at the Dun Echt Observatory; Herr Tempel, at Arcetri; and others also had been attracted by it during the summer of 1878. The next year it was the subject of general attention amongst astronomers, and not without reason. Its deep colour—a strong brick-red—its great size, its well-marked outline and definite shape, made it a most attractive object. Here there was something relatively stable and permanent; something more substantial than the weird succession of beautiful but evanescent cloud-forms which follow each other so swiftly across the Jovian disc. This was just what had been wanting to Jupiter before. The charm of variety had always been his; there had been also a certain stability about the arrangement of his belts; and his detailed markings had been formed after a few distinct types: but there had been nothing of such strongly marked individuality of character and such persistence of life till the red spot appeared.

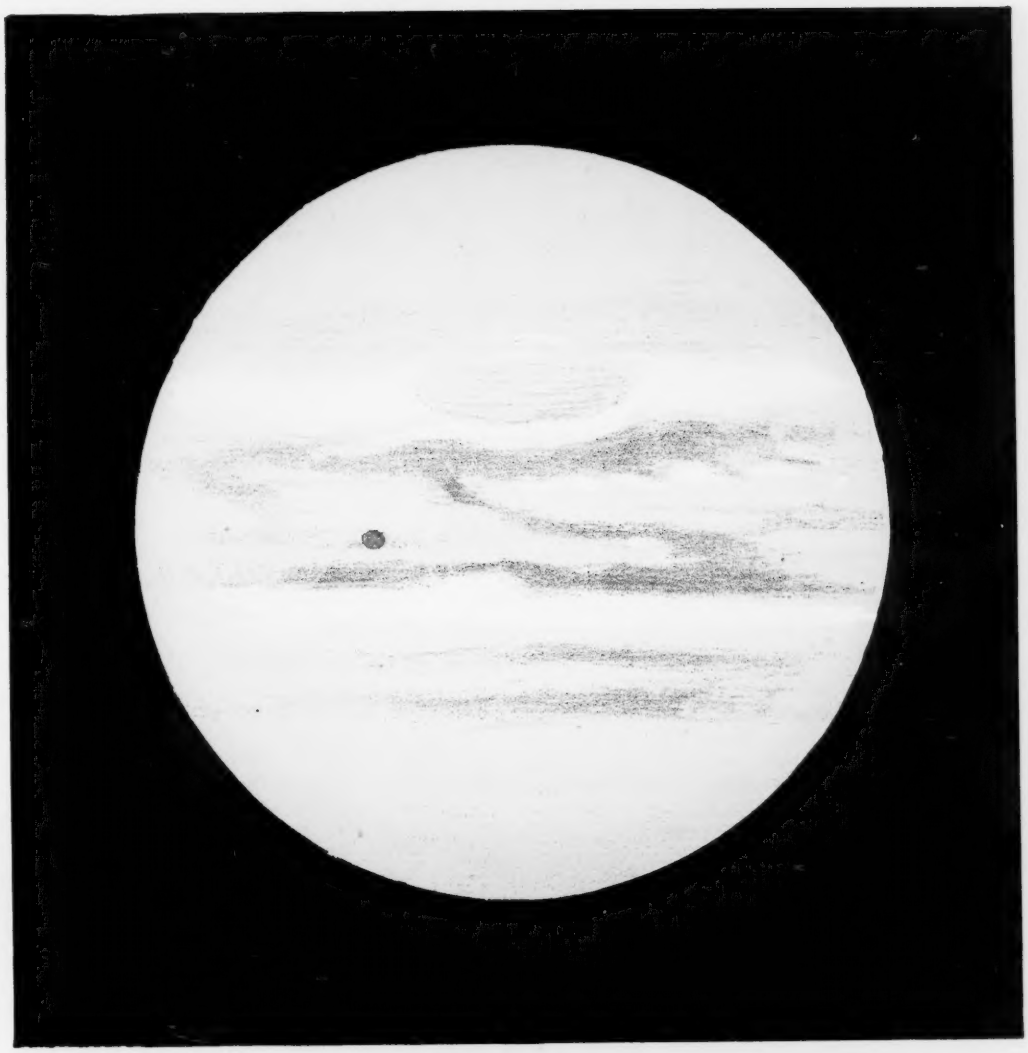
The first question which its discovery aroused was, "Has it been seen before?" Clearly it had not been so conspicuous before, but a fair amount of evidence was forthcoming that, for eight or nine years prior to 1878, the spot had been seen occasionally. Thus, Mr. H. C. Russell, at Sydney, observed what appears to have been the spot in 1876; Mr. Terby and Mr. Corder represented a similarly placed but smaller spot in 1872; and in 1869 and the following year Mr. Gledhill remarked in the same latitude, not, indeed, the red spot as such, but a hollow ellipse, not unlike the aspect it was destined to wear some fifteen years later, during the progress of its fading from its greatest distinctness.

There may have also been earlier records, but from 1878 to the present time it has been under observation at each succeeding opposition; and certainly the impression it then produced upon the most experienced observers of the planet was that it was quite a new order of feature. We may take it, then, as practically a new object in 1878; new, at all events, as to its definiteness.

That definiteness it did not long retain. In the succeeding oppositions it showed itself as continually growing paler and paler. Its outline remained much the same, but the interior of the spot appeared filled with white material, or the white cloud formed above it. By the end of May, 1883, only the faintest, feeblest ghost of the spot remained, and observers feared it was lost to them. It reappeared, however, during the next opposition, though still very faint, and it has undergone some minor fluctuations in brightness since. In 1891, for instance, it presented again the appearance of an elliptical ring, the interior being lighter and whiter than the margin. But it was now quite different from Gledhill's oval of twenty-one years earlier, the dark margin being broad and dense and the white interior small. The following year it was very faint—the preceding end especially so—and the neighbouring belt interfered with its southern border.

We have therefore had the great red spot with us for certainly seventeen and a half years; and it is probable that it existed, but in a less conspicuous form than in 1878, for quite nine years before. During this time its colour and its distinctness have altered much, but its size and shape little.

That a marking of area fully equal to three-fourths that of the surface of the entire earth should continue practically unchanged in size or shape for seventeen years on such a



JUPITER.

From a Coloured Drawing by Mr. N. E. Green, F.R.A.S.

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world as Jupiter is a sufficiently striking circumstance, and led at once to the suggestion that here we had a glimpse of the real solid surface of Jupiter. But the observations of three most careful and acute observers—Mr. Denning, Mr. Stanley Williams, and Prof. Hough—combined to prove that the red spot had a most remarkable peculiarity: it changed its rate of rotation.

The following table by Mr. Denning (*Nature*, September 3rd, 1891, vol. xliv., p. 439) speaks for itself:—

ROTATION PERIODS OF THE GREAT RED SPOT.

Limiting Dates.	No. of Rotations.	Rotation Period.
		h. m. s.
1879, July 10th—1880, February 7th ...	512	9 55 34·2
1880, September 27th—1881, March 17th...	413	35·6
1881, July 8th—1882, March 30th	640	38·2
1882, July 29th—1883, May 4th	674	39·1
1883, August 23rd—1884, June 12th ...	710	39·1
1884, September 21st—1885, July 8th ...	700	39·2
1885, October 24th—1886, July 24th ...	659	41·1
1886, November 23rd—1887, August 2nd ...	609	40·5
1888, February 12th—1888, August 22nd ...	462	40·2
1889, May 28th—1889, November 26th ...	439	40·0
1890, May 22nd—1890, November 25th ...	451	40·2

The rotation period has remained fairly constant in more recent years.

Briefly stated, it implies that in seven years the rotation period of the spot lengthened by seven seconds, a statement which is equivalent to saying that if the first rotation period given above represents the true rotation period of Jupiter, this vast formation, whatever its real character, had travelled eastwards with a constantly accelerating speed until it was moving at a rate which would bring it back to its starting point in less than six years, and which would suffice to make the tour of the earth's equator in about seven months. If we could imagine Australia to set off on its travels, and to quietly traverse the Southern Ocean towards Africa at a speed of a little over four knots an hour, we should have a very fair representation on the earth of what appears to be taking place on Jupiter, for Australia bears about the same relation as to area and position to this planet as the great red spot to that.

This fact seems to shut us off from adopting the suggestion which the relative persistency of the spot in shape and size so naturally suggests; viz., that we have here a glimpse of the solid surface of the planet, or, perhaps, a partial crusting over a liquid nucleus. The latter idea is not absolutely irreconcilable with these observations of drift, for it is quite conceivable that such a crusting might become gradually dissolved away on the western side—speaking now, as always, as from the point of view of an inhabitant of Jupiter—and be extended at about the same rate on the eastern. A slight variation in latitude which has also been remarked might be explained in the same way; and the greater stability of rotation period at the present time would imply that the crust had now attained a greater consistency, and had ceased to undergo this double process. Its present rotation time would then be the rotation time of the planet itself.

We cannot, however, adopt this suggestion, for if the red spot is a surface marking, then the white region which has surrounded it, and which, as a complete annulus surrounding the spot, has been even more conspicuous on photographs than to the eye, must be due to clouds—must be, in effect, at a higher level. This transfers the marvel of the persistency of the shape and size of the spot from the spot itself to the overlying cloud ring. Of the true shape of the actual spot itself we can know nothing; the shape of that which we see of it is defined wholly and entirely by the gap in the cloud region above.

When the spot was first observed in 1878 and 1879 its similarity in hue to the great ruddy equatorial belt was frequently remarked upon; and, as several observers have remarked—Prof. Keeler in particular* (*Publications of the Astronomical Society of the Pacific*, No. 11)—the appearance of the equatorial regions is strikingly like what we should expect if the white cloud-like formations were floating at various heights in a reddish fluid. It is reasonable, therefore, to suppose that were the cloud masses removed we should see the whole of Jupiter as of the same deep hue as the red spot possessed in 1878 and 1879.

This would be in perfect harmony with the opinion at which almost every student of the planet has arrived, and not by one course of reasoning alone, but by many, viz.: that Jupiter still retains a very considerable amount of intrinsic heat, and the red tint might be reasonably ascribed to the glow of heated material far below the apparent surface, or possibly even to the high temperature of the lower strata of the atmosphere itself.

That the problem of the persistency of the outline of the spot is really one of the persistency of the upper cloud masses is, I think, shown by the definiteness of the "shoulder," at one time very clearly an integral part of the complete phenomenon, and its most stable and obvious feature in recent years. Read by the light of some of the photographs taken by the Brothers Henry, the red spot was produced by a disturbance in a bright white belt. The belt at a certain point divided into two arms, which, arching round, the one to the north and the other to the south, reunited again some forty degrees of longitude further on; the enclosed space being the celebrated spot, and the commencement of the arch on the north following side the equally well-known "shoulder."

This transference of the site of the problem does not, however, help us to a solution. We may see in the gradual diminution of the rotation period a subsidence of the cloudy surroundings defining the spot, and in the fact that the spot seems now to have adopted a steady rate, an indication that the vapours have reached a level where they are in more stable equilibrium. But the great mystery how and why, amidst so many changes, the *outline* of the spot has shown so little change remains a mystery still. Perhaps the mode of dissolution of the spot, should it be fated to disappear, may give us a means of fathoming it that at present we lack.

JUPITER.

THE drawing of Jupiter that accompanies this number of KNOWLEDGE was made on the 17th of April, 1885, at 10 p.m., with an 18-inch reflector and powers of 300 diameters. The opposition of this year was particularly favourable for obtaining views of Jupiter, the writer having made one hundred and fifty-six drawings of the planet. The large red spot, though not so clearly seen as in previous years, was still distinctly visible, although the colour had faded. The general details of the disc were well marked, and with their various colours gave great interest to the study. The large red spot was followed by two similar markings; the first of these was about the length of the spot distant from it, on the same latitude. It was first observed in March of that

* "The red belts presented on all occasions the appearance of a passive medium, in which the phenomena of the streamers and other forms shown in the drawings were manifested. These phenomena would be exactly reproduced by streamers of cloudy-white matter floating in a semi-transparent reddish fluid, sometimes submerged and sometimes rising to the surface, and it is by no means impossible that such is actually their nature."

year as a grey mark, which became red in April, and continued visible till June. The southern edge of the south belt was also very red at times, much more so than the great spot, so that there was a tendency to become red in various portions of the southern hemisphere. The round dark mark near the equator is the shadow of the second satellite.

NATH. E. GREEN.

PERIODICAL COMETS DUE IN 1896.

By W. T. LYNN, B.A., F.R.A.S.

OF all the periodical comets whose orbits are known with some accuracy, two only are due to return to perihelion in 1896. One of these has been seen at seven previous returns, all consecutive; the other has hitherto been seen at only one appearance, unless a remarkable theory which was then started should be found on the forthcoming return to have been founded on fact.

The former of these two comets is that known as Faye's, because it was first discovered by the veteran astronomer, M. Faye, at Paris, on the 22nd of November, in the year 1843. Its orbit was calculated to be a short ellipse, with a period of about seven and a half years, and it duly returned to perihelion in 1851, being first seen on that occasion by Prof. Challis, at Cambridge, on the 28th of November, 1850. It has also been observed at every subsequent return, and was last in perihelion on the 20th of August, 1888. Another return to that position will be due on the 19th of March next, but the comet was nearest to the earth in October last, and was seen by M. Javelle at Nice so early as the 26th of September, nearly six months before perihelion passage. This comet is a very faint object, and has never been visible to the naked eye. Its orbit is remarkable for its very small eccentricity, which amounts to only about 0·55. When in perihelion, the comet never approaches the sun so nearly as the greatest distance of Mars; when in aphelion, its distance somewhat exceeds that of Jupiter, and it was probably the attraction of that planet which first brought it into our system.

The other comet to which we referred was discovered by Mr. Brooks, of the Smith Observatory, Geneva, N.Y., on the 6th of July, 1889. Mr. S. C. Chandler, of Boston, U.S., showed that it had made a very near approach to Jupiter three years before, which would have the effect of greatly changing its orbit. Now, a comet discovered by Messier, at Paris, more than one hundred and twenty-five years ago, on the 14th of June, 1770, was calculated by Lexell to be moving in an elliptic orbit, with a period of only five and a half years, but failed to put in an appearance when afterwards due, so that it acquired the name of Lexell's lost comet. This failure, however, was explained as arising from violent perturbations produced by the attraction of Jupiter. The comet had in fact approached that planet in 1767 within a distance of only about one-sixtieth part of the radius of Jupiter's orbit, and this circumstance it was that brought the comet within view from the earth, which it approached in 1770 within a distance of little more than seven times that of the moon. It probably returned to perihelion in 1775 or 1776, but in a position unfavourable for observation; and in 1779, before another return was due, it approached Jupiter even closer than before, coming, indeed, nearer to that planet than the distance of his fourth or most distant satellite, and its orbit thus again undergoing a great alteration. Now, Mr. Chandler thought, from his calculations, that the comet discovered by Mr. Brooks in 1889 might be Lexell's comet, brought once more into visibility from the earth by the attraction of Jupiter in 1886. Dr. C. Lane Poor, however, made a re-investigation of its motions, the result of which was not to confirm this theory. Mr. Brooks's comet was moving when discovered in an orbit with a period of nearly seven years, so that it will probably come into perihelion again in the spring or summer of the present year. It is hoped that it will be possible to obtain observations on that occasion, by which astronomers will be enabled to come to a definite decision with regard to the suggested identity with Lexell's lost comet of 1770. The orbit, as determined from those made in 1889, is even less eccentric than that of Faye's comet, and the perihelion distance from the sun is greater than the mean distances of some of the small planets, being more than twice as great as that of the earth. The eccentricity of the orbit amounts to only 0·48; this is the smallest of any known comet, with the doubtful exception of one denominated Tempel's first periodical comet, which was discovered by the late M. Tempel at Marseilles in 1867 and observed at returns in 1873 and 1879, but not seen subsequently. It should be added that M. Schulhof has recently made some calculations which seem to show that the comet discovered by Prof. Swift in August last year (and not Brooks's of 1889) was identical with Lexell's. The period of Swift's comet is about seven and a-quarter years, but at the next return in 1902 it is likely to be very unfavourably placed for observation, particularly in the northern hemisphere, so that we may have long to wait for the decision of this question.

WAVES.—I.

THE WAVES OF THE OCEAN.

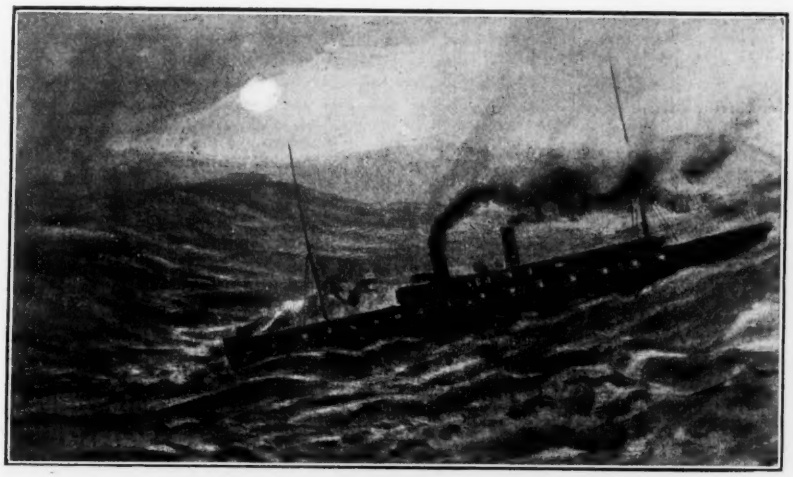
By VAUGHAN CORNISH, M.Sc.

WHEN the lightest zephyr passes over a perfectly calm sea the glassy surface remains unruffled. As Byron wrote :—

> "Winds come whispering lightly from the West,
> Kissing, not ruffling, the blue deep's serene."

A breeze which travels at rather more than half a mile an hour just ruffles the water, darkening the surface, which no longer reflects like a mirror; but if the breeze drops the wavelets instantly cease and the water resumes its glassy look. If, on the other hand, the breeze increases until it has a velocity of about two miles an hour, permanent waves begin to rise, which increase in size as the wind continues to blow. The form of the waves in a rising sea is somewhat different from the smoothly sloping curve of a ground swell, for whilst the waves are rising the crests are exposed excessively to the force of the wind, and the troughs are sheltered. The tops of the waves are consequently driven forward, and break at the crest into the "white horses" which chase each other across a rising sea. At first the wind increases the height of the waves over every part of the sea upon which it blows, but after a time the waves near the windward shore attain such dimensions that the power of the wind is only sufficient to maintain, without increasing, them. Further to leeward the waves are still increasing, and still show the "white horses." However long a wind of constant strength may blow, the height to which it can raise the waves in any part of the sea is limited, being greater, however, as the distance from the windward shore increases. This increase in the size of the waves can readily be explained, for at any place the sea is raised not only by the force of the wind there, but also by the energy transmitted from the leeward waves. Off the coasts of Britain the greatest waves—greatest not only in height, but more especially in length from crest to crest—come rolling in from the broad

Atlantic. The narrow seas of the English Channel give shorter, lower waves: often steep and breaking at the crest, choppy, lumpy, sometimes dangerous and always disagreeable, but lacking the majesty of the great ocean waves. It is with the short, steep waves that most of our marine painters are familiar, and it is rare to find a picture or a photograph which shows the long waves of mid-ocean. Our first illustration is from a water-colour drawing kindly placed at our disposal by the artist, Mr. G. H. Andrews, F.R.G.S. It shows a steamer of about two thousand tons sliding down the long slope of a wave in mid-Atlantic. She was sighted on a moonlight night when passing the ship on which the artist was homeward bound.



A Steamer sliding down the Slope of an Atlantic Wave.

We have so far dealt with the raising of waves by the wind; let us now examine the course of events when the wind drops after a storm. The storm waves do not die out at once with the falling of the wind, as is the case with the wavelets raised by a passing breeze; on the contrary, the long rollers follow one another in unbroken succession for days after a storm, breaking at regular intervals upon the leeward shore with a solemn booming sound which is the more impressive from the stillness of the air. The smaller and shorter waves, raised latest by the wind upon the flanks and in the troughs of the greater waves, are the first to die out after the wind lulls, and the heaving surface of the sea is no longer chequered with the intricate interlacing undulations of lesser waves, but

> " . . the broad bosom of the ocean keeps
> An equal motion, swelling as it sleeps."

These waves, which travel independently of wind, are called *free waves*, in contradistinction to the *forced waves* of a rising sea driven forward by the strength of the wind.

Some of the best observations of ocean waves are those made by Dr. Scoresby during a homeward passage across the Atlantic in 1848. On March 5th the ship *Hibernia* was in lat. 51° N. and long. (at noon) 38° 50′ W., the wind being W.S.W. and the ship's course true N. 52° E. By sunset of the previous day the wind was already blowing a hard gale, which continued with heavy squalls during the night, so that all sail was taken in except a storm-staysail forward. On the afternoon of the same day Dr. Scoresby took up his post of observation on the saloon deck, which gave an elevation of the eye twenty-three feet three inches above the water-line. He found, however, that every approaching wave intercepted the horizon, so that from this position he could decide little except that the average height of the waves, reckoned from

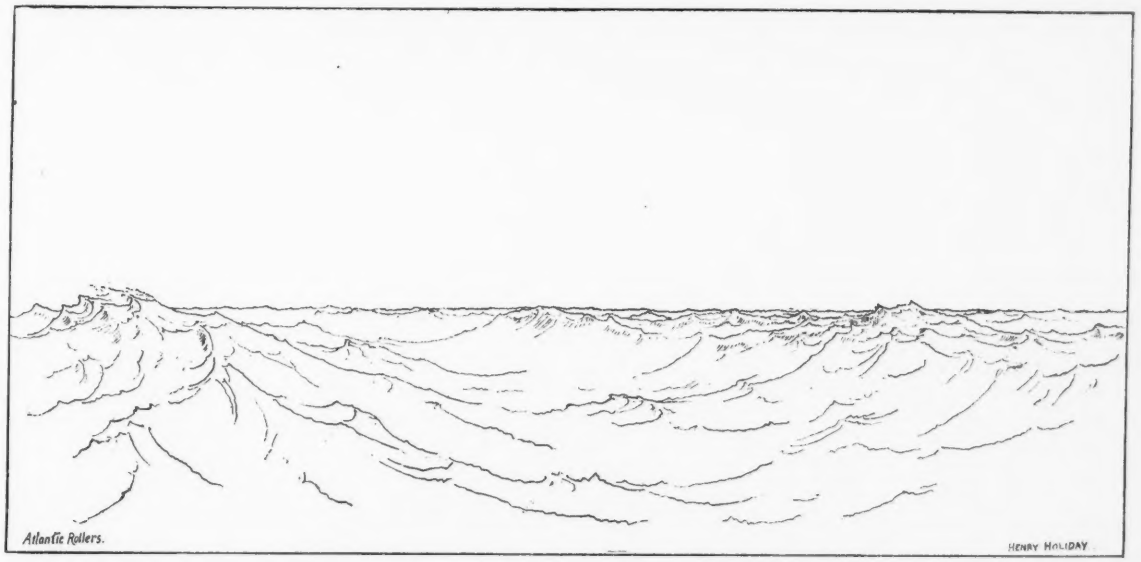


FIG. 2.—Atlantic Rollers. Reduced from an Original Drawing by HENRY HOLIDAY.

trough to crest, was more than twenty-four feet. He, therefore, ventured upon the port paddle-box, which was seven feet higher, giving an eye elevation of thirty feet three inches. This level was maintained during the actual moments of observation, for the whole of the ship's length (two hundred and twenty feet) was clear within the trough of the wave when the next following crest was at its greatest apparent height, and the ship at these moments was on an even keel. From this elevated position quite one-half of the waves which overtook and passed the ship were above the level of the observer's eye. Sometimes a crest extending in a ridge one hundred yards long would be from 2° to 3° above the visible horizon, which would give a height from trough to crest of more than forty feet. Sometimes the crossing of two wave-crests would send up a sharp peak of water ten or fifteen feet higher than this, or the crest of a breaking wave would shoot up to similar height. The average height of the waves during the observations of March 5th was thirty feet. On the 6th, at ten a.m., the wind having lulled some hours previously, Dr. Scoresby took up his usual post upon the saloon deck, from which he estimated that the average height of the waves was still as much as twenty-six feet. He then set himself to determine the velocity of the waves, and their length from crest to crest. The ship was travelling at nine knots; the wave-crests overtook the ship at intervals of sixteen and a half seconds, and each wave travelled the distance of two hundred and twenty feet, from stem to stern, in six seconds. The length from stem to stern would appear, therefore, to have been little more than one-third of the distance from crest to crest. This proportion would give a wave-length of six hundred and five feet, but a necessary correction for the effect of the small angle between the direction of the ship's motion and that of the following waves reduces this to five hundred and sixty feet for the true wave-length. It follows, therefore, that five hundred and sixty feet of the wave passed the stern of the vessel in sixteen and a half seconds. But the ship during this time moved two hundred and thirty feet in the direction of the wave's motion. The true distance traversed by the wave in sixteen and a half seconds was therefore seven hundred and ninety feet, which gives a velocity of thirty-two and a half statute miles per hour.

During the height of the gale the forms of the waves were less regular than after the wind had begun to subside; the greater waves were chequered with many minor or secondary waves, and the greater waves did not for the most part range themselves in long parallel series, as do the rollers near shore when retarded by the shallowing water.

Fig. 2 shows an Atlantic wave such as those described by Dr. Scoresby, with a length of about six hundred feet from crest to crest. The wave is travelling from right to left, the right flank of the crest being that which is exposed to the wind. In judging of the relation of height to length it must be remembered that the view is somewhat foreshortened. The figure is from a sketch made at sea by Mr. H. Holiday, who has kindly placed the drawing at our disposal.

In order to understand waves we must study, not only the motion of the wave, *i.e.*, the steady onward rush of the wave-crest, but also the motion of a particle of surface-water situated in the path of the wave. Some information as to the motion of the water-particle may be gained by watching from a pier the movements of a light floating body outside the line of breakers. When a wave-crest approaches, the body moves upwards and forwards; then, at the crest of the wave, it is for a moment moving forwards only; when the crest passes it moves first downwards and forwards, then downwards and backwards, until, in the trough of the wave, the body is again in its first position and is for a moment moving horizontally backwards, *i.e.*, seawards, before rising again as the next wave-crest approaches. More exact observation, agreeing with mathematical calculation, shows that the motion of the particle is, in deep water, almost perfectly circular, the diameter of the circle being in the direction in which the wave is travelling. The particle of water moves with uniform velocity, and the time of one complete swing of the particle round its circle is equal (as follows from what has been already said) to the interval between the passage of succeeding wave-crests. The vertical distance through which the particle moves is equal to the height from trough to crest. Again, from the fact that the motion is circular, it follows that the particle moves through a *horizontal* distance equal to the height of the wave from trough to crest, *not* (be it well understood) equal to the wave-length, or distance from crest to crest.

The velocity of the particle, it must be remembered, is by no means the velocity of the wave. The particle takes the same time to move uniformly round its small circle that a wave-crest takes to pass over a whole wave-length—say ten times the distance, even in a very rough sea.

The more rapidly a wave-crest travels the greater will be the distance which separates it from the next wave-crest. This connection between velocity and wave-length is an important property of water waves, which run by the action of gravity. In sound waves, on the other hand, the velocity is independent of wave-length. In order to explain the connection between the wave-length and the velocity of water waves, we cannot do better than adopt the artifice employed by Newton in the second book of the "Principia." He represents the water as contained in a U-tube (see Fig. 3, taken from an edition of 1729). If the

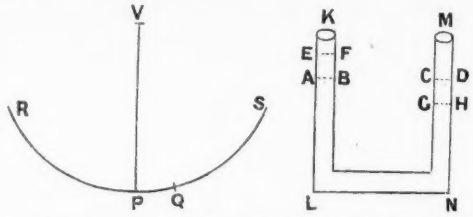


FIG. 3.—"If water ascend and descend alternately in the erected legs KL, MN of a canal or pipe; and a pendulum be constructed, whose length between the point of suspension and the centre of oscillation is equal to half the length of the water in the canal: I say, that the water will ascend and descend in the same times in which the pendulum oscillates."—Newton's "Principia," Book II.

tube be agitated, the level of the water oscillates up and down in the two limbs. The level in one limb being E F, and in the other G H, the *weight* of so much of the left-hand column as is above E A moves the whole of the liquid. This column of liquid is a falling body, but not a body falling freely. Its descent is retarded by the fact that it has to overcome the inertia of the remainder of the liquid. The oscillations of the liquid in a tube of given length are executed in equal times whether they be great or small, just as are the decreasing oscillations of any pendulum. The time of an oscillation depends upon the length of the whole column of water, in the same way that the time of swing of a pendulum depends upon its length. If the length of the pendulum be doubled the time of one oscillation is increased fourfold; if the length be tripled the time of oscillation is increased nine times; and so on, the length of the pendulum being proportional to the *square*

of the time. The relation is due to the fact that the force of gravity is *continually* acting. The relation may be otherwise stated by saying that the time is proportional to the square root of the length. Now, in our U tube the portion E F, at the moment represented, is the crest of a wave, and G H is the succeeding trough.* The interval of time which will elapse before G H is the crest is proportional to the square root of the length of the column of water; or, the velocity with which a wave-crest appears to travel over the surface of the water is greater in proportion to the square root of the wave-length. From this we see that, if any cause of disturbance starts a wave of a certain velocity, the distance from crest to crest will depend upon this velocity, and in the precise manner above stated. From the known length of the seconds-pendulum (or, to put it otherwise, from the known value of the acceleration due to gravity) the wave-length proper to any given velocity can be calculated. The following approximate rule will be found useful for numerical calculations relating to water waves, viz., that—five times the wave-length is numerically equal to the square of the velocity, lengths being expressed in feet and time in seconds. This rule gives a velocity of about forty feet per second, or twenty-seven miles per hour, for waves three hundred feet from crest to crest, such as are observed in the Atlantic after a storm.

The depths of the ocean are undisturbed by the waves with which the wind covers the surface, for the excursions of the swinging particles diminish very rapidly as the distance from the surface increases. In an Atlantic storm-wave, with surface particles swinging round a circle of forty-foot diameter, the motion at a depth of three hundred feet is calculated to be not more than half an inch; so that we may say that at a depth greater than the distance from crest to crest the water is undisturbed by winds, and, conversely, where there is such a clear depth of water the formation and the motion of the largest wind-waves is not hindered or modified by the sea bottom. Some seas, however, are really very shallow. The depth of the North Sea is not more than half the distance from crest to crest of a full-grown Atlantic wave; it would be difficult to find a spot in the North Sea where St. Paul's Cathedral would be completely submerged.

When the depth of water is small relatively to the wave-length the motion of the water particles is greatly modified, and we encounter the more varied phenomena of waves in shallowing water, culminating in the waves of the sea-shore and the ever-beautiful breaking wave—of all of which more anon.

THE BANANA.

By RICHARD BEYNON.

NEVER in the history of the world's trade has there been so marked an example of an edible article of commerce attaining within a comparatively short period the popularity achieved by the banana. It is not long ago that this luscious product of the tropics was only heard of as a vegetable curiosity. Occasional parcels were brought to England by vessels trading from the West Indies or the West African islands; but these reached no farther than the narrow circles of the friends to whom they were sent. The omnivorous British public remained practically ignorant of the rich, wholesome fruit which nature was ready to produce so bountifully. Now, however, no fruiterer's stock is complete without its bunches of richly-tinted bananas; while the enterprise of the "coster" and other itinerant vendors has placed the fruit within the reach of the poorest.

Originally the banana was a native of the eastern tropics, but now it is cultivated in all tropical and sub-tropical countries, whether in the Old or New World.

The plant itself is a peculiar one, the stem, which attains a height of fifteen or twenty feet, being practically formed by the sheathings of the leaves, the blades of which reach the very respectable dimensions of eight or ten feet in length and eighteen inches or two feet across. The fruit clusters, which branch from the stem, have been known to weigh upwards of ninety and even a hundred pounds. A bunch of average bananas contains eight hands of ten bananas, while those of inferior quality will consist of but six or seven hands.

The productiveness of the banana plant is enormous. We are sometimes wont to refer to the productive power of grain or the potato as examples of extraordinary fertility. But, according to Humboldt, the banana is more than a hundred times as productive as wheat and forty-four times as productive as the prolific potato.

As a complete article of food, containing in itself the principal elements necessary to preserve the human machine in health and strength, this fruit is one of the completest with which nature has furnished us. The principal constituent is of course water, which practically forms three-fourths of the weight of the banana. Sugar, pectine, etc., compose about twenty per cent., while nitrogenous matter is, roughly speaking, accountable for the remaining five per cent.

In many tropical areas the banana is the staple food, and from the unripe, sun-dried fruit a most nutritious flour is manufactured. In fact, this fruit is to a great section of the inhabitants of the tropics, and the regions adjoining, what wheat is to the European and rice to the Hindoo.

Twenty-five years ago, some men interested in the New York fruit trade prophesied a big future for this fruit. Thinking that there might be "money in the business," a fruit merchant introduced to the buyers of New York a shipment of four thousand bunches; but this initiatory effort does not seem to have met with much success. Ten years later, another consignment of ten thousand bunches was shipped from Jamaica, and no difficulty was experienced in securing a ready sale. *Now*, the trade in bananas between New York and the West Indies forms a special department of commerce, for which vessels are specially built and equipped.

The quantity of bananas shipped from West Indian and adjacent ports into the United States now amounts to thirteen or fourteen million bunches annually, valued at considerably over four millions sterling. Our own possession of Honduras exported, in 1880, bananas to the value of seven hundred pounds, while at present the annual value of this fruit exported is close upon fifty thousand pounds. From one port alone, on the shores of the Caribbean Sea, two hundred and fifty thousand pounds worth of bananas are exported each year.

The fruit which finds its way to England comes almost entirely from Madeira and the Canary Islands. Before long, however, the West Indian banana will enter the field as a powerful competitor, the arrangements for the safe and speedy sea-carriage of the fruit now rendering such a contingency quite feasible.

The bananas intended for export are cut when green, and consequently unripe, and carefully packed in long and loosely constructed baskets, or wooden crates. The

* It is to be borne in mind that in the proportions obtaining in actual waves, the vertical limb of the supposed tube is short compared with the length of the horizontal part.

bunches of fruit are encased in cotton wool, and while great care has to be taken to protect them from damp or frost, thorough ventilation must be maintained as well. On arrival at the fruit merchant's warehouse, they are stored in dry, airy rooms, the temperature of which is regulated by the condition of the fruit, and the length of time it is proposed to keep it before placing it upon the market. Thus, fruit which is wanted to ripen slowly may be kept at a steady temperature of 55° to 60° Fahrenheit, while the ripening process may be easily accelerated by increasing the temperature. When properly ripe, the outer skin assumes that delicate canary hue which colour experts maintain has no other exact parallel among the tints with which nature invests her vegetable products.

OUR FUR-PRODUCERS.—I.

OTTERS, SKUNKS, BADGERS, AND GLUTTONS.

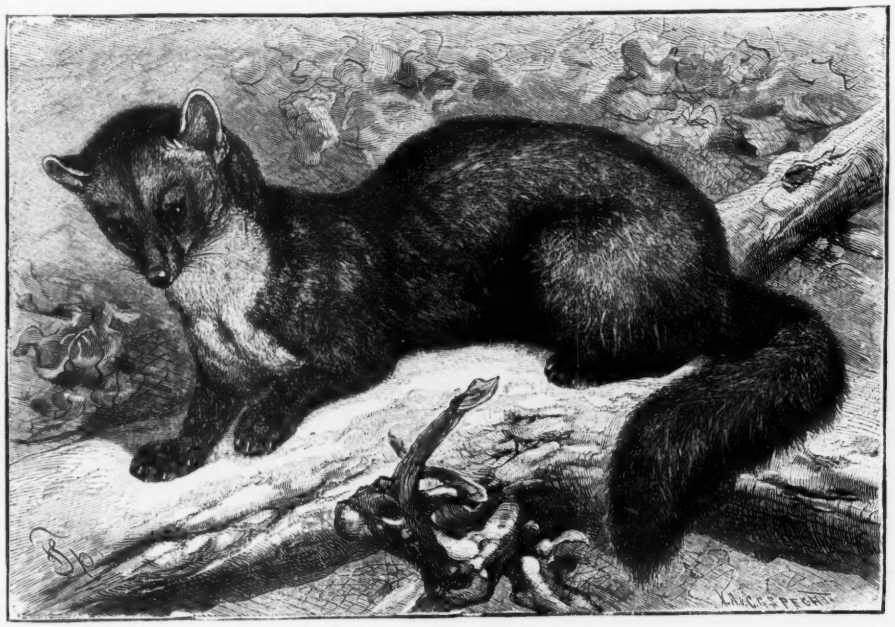
By R. LYDEKKER, B.A.Cantab., F.R.S.

THE skins of mammals have always played an important part in human clothing from the very earliest times, when they were dressed with rude scrapers of flint, obsidian, or other kinds of stone. Before the art of weaving became known, they appear to have constituted the entire dress of our savage ancestors, and although in temperate climates they are now to a great extent articles of luxury, in the Polar regions they are absolute necessities. The trade in furs at the present day is enormous, the value of those sold in London alone being estimated a few years ago at little short of a million sterling; and the recent rise in the price of some of the more valuable kinds suggests that this estimate may now be considerably below the mark.

Although the term "fur" is commonly regarded as distinct from wool, yet in nature there is a more or less complete transition from the one to the other, so that in any essay on fur-producing animals, it is difficult to exclude those that yield wool. Nevertheless, whereas wool, as such, is employed in the manufacture of textile fabrics after its removal from the skin, while furs are the whole "pelts" of the animals by which they are yielded, we have an obvious distinction, so far as manufacturing purposes are concerned. Accordingly, in the present series of articles, our attention will be directed to pelts alone. It would, of course, be impossible within the limits of our space to mention even by name all the animals whose pelts are used in commerce; and we must therefore confine ourselves to such as are most commonly employed, and to those which, from their beauty or rarity, command the highest values in the market. It must not, however, be supposed that those which fetch the highest price at one time will do so at another, for fashion in furs, as in everything else, changes; and skins which are in high demand in one season may be a drug in the market in the next. Consequently, fluctuations in value of from forty to sixty per cent. are by no means uncommon; and probably these fluctuations are of some importance in keeping up the supply, for whereas, when its skin is in fashion, a species of mammal will be relentlessly hunted, when the mode changes the creature has a more or less complete respite for a season. Nevertheless, there are certain pelts, such as those of the sea-otter and silver-fox, which always maintain an exceptionally high value.

Fur and wool, both of which are merely varieties of hair, are the products of mammals alone; but whereas the great majority of that class grow hair of some kind or other, it is chiefly among particular groups or families that the most valuable furs are produced. One of the most valuable families of all in this respect is that of the weasel tribe—the *Mustelidæ* of zoologists—which comprises the martens, ermines, otters, and sea-otter; and certainly no other group includes such a large number of valuable fur-bearing species. But the fur-seals (*Otariidæ*), although less numerous in species, likewise occupy a high position, on account of the large size of their pelts and the number of individuals by which they are represented. Among the abundant yielders of less valuable furs may be mentioned the squirrel family and the hares and rabbits.

It is a somewhat curious comment upon the susceptibilities of human nature that, whereas we are continually being reminded of the iniquity of our ladies in adorning their hats and bonnets with the plumage of birds, yet no one has a word to say against the enormous slaughter of mammals that is continually taking place for the sake of their pelts. No one, we believe, has ever thought of establishing a "fur league," and yet it is extremely doubtful whether the cruelty which is certainly exercised in the

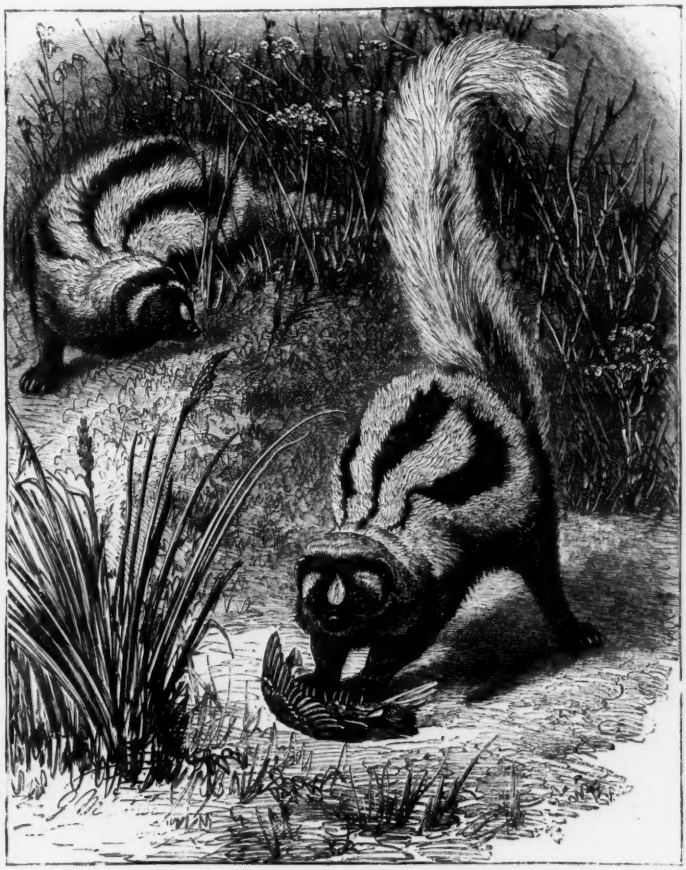


The Pine-Marten. (One-fourth natural size.)

acquisition of birds' plumes is not equalled, or even exceeded, in procuring the pelts of mammals. Possibly this apathy is largely due to the fact that, whereas mammals, from the nocturnal habits of the majority of the fur-yielding kinds, are but seldom seen, birds are always with us.

Much might be written as to the various modes of dressing and preparing the raw pelts for use, but as this would entail too much space, we proceed at once to notice the chief groups of fur-producing mammals. Here a strict zoological arrangement will not be followed, as it seems preferable to deal first with such groups as either contain the greatest number of fur-bearing species, or comprise forms whose pelts are remarkable for their extreme beauty or high commercial value.

We take then, first, the weasel tribe (*Mustelidæ*), which includes the sea-otter, true otters, badgers, gluttons, ermines, martens, skunks, and others, among which the sea-otter (*Latax lutris*) stands pre-eminent here, having the most valuable pelt of any mammal. It will be unnecessary here to point out the characteristics of the family, but it may be mentioned that all its members agree in having only a single pair of molar teeth in the upper jaw, and never more than two pairs of such teeth in the lower jaw; the upper molars being remarkable in that they are generally wider on the inner than on the outer, whereas in the majority of the Carnivora the reverse is the case. The great majority of the members of this family are inhabitants of the northern hemisphere, where, with the exception of certain otters and skunks, all the species whose pelts are valued in commerce occur. And it may be mentioned that, as a rule, the further north we go the more valuable do the pelts become, while it is only in northern regions that certain species are white for a portion or the whole of the year.



The Cape Polecat. (One-sixth natural size.)

Although presenting many structural features in common with the freshwater otter, the sea-otter stands apart from all in the peculiar structure of its hinder grinding teeth, which, in place of being surmounted by sharp cusps and ridges suited to holding the slippery skins of fishes, have blunted, mammillated crowns, admirably adapted for crushing the shells of the crabs on which this animal feeds. It is also peculiar in having only two pairs of front, or incisor, teeth, in place of the usual three. But its most remarkable feature is to be found in the structure of the hind feet, which form webbed flippers, with the toes much elongated. It has been usually considered that when on land the sea-otter stands with its hind feet bent forward under the body like an ordinary mammal; but according to the observations of Mr. Snow, who has hunted and killed these animals on the shores of the Kurile Islands, this is incorrect, the flippers, both when walking and swimming, being turned backwards, in the same manner as are those of an ordinary seal. In appearance, the sea-otter may be compared to a very large freshwater otter, with a shorter body and legs, a short and blunt face, bearing whiskers somewhat like those of a cat, and a short, flattish, and somewhat bushy tail, ending suddenly in a bluntish point. The fur is generally some shade of dark brown, although occasionally lighter, and among it are a certain number of longer white hairs, which are not removed in dressing, and form its chief beauty. Sea-otters, which are now rare animals, and never appear to have been abundant, are found on both sides of the Pacific, ranging in America as far south as Mexico and California, and on the Asiatic side to Kamschatka and the Kurile Islands; the Aleutian and Kurile Islands being the localities where they are least uncommon. A few years ago, between £80 and £90 was a high price for the pelt of a sea-otter, but by 1892 £100 was no uncommon price, while as much as £200 had been given for an unusually fine example. At a sale in London in the spring of 1895, the hitherto unheard-of price of £225 was paid for one by a Russian nobleman. This splendid specimen had been stripped off the animal entire, glove-fashion, without the usual slit up the lower surface, thus preserving both upper and lower surfaces intact. Such a price has, we believe, never before been given for a single pelt of this or any other animal. Sea-otters are either hunted by men in boats and shot, or caught in nets, when they meet their death by drowning.

True otters (*Lutra*), of which there are a considerable number of species scattered over all parts of the world, except Australasia, Madagascar, and the Polar regions, are too well known to need anything in the way of description;

and their fur, chiefly in the form of trimming, is likewise sufficiently familiar. Although otter-pelts may be classed among the more valuable furs, their price bears no comparison to that of sea-otter fur; and it is noticeable that the pelts of the southern species are of considerably less value than those of the northern kinds or races. For instance, whereas skins of the small Indian otter (*L. cinerea*) sell for only a shilling each, while those of the big Brazilian species (*L. brasiliensis*) fetch only from one to six shillings, the price of a pelt of the common European otter (*L. vulgaris*) ranges from five to thirty shillings. Canadian otters (*L. canadensis*), which are larger and finer, attain still higher values, selling at from thirty to fifty shillings a-piece; while in 1889, fine Labrador skins fetched as much as ninety-five shillings. Some idea of the importance of otter-skins in commerce may be gathered from the fact that, according to Mr. Poland, upwards of ten thousand skins of the European species are sold annually at the pelt fair in Leipsic; while in Prussia alone over four thousand individuals were killed during the winter of 1885-86. As regards the American species, in the year 1891 over eight thousand skins were sold by the Hudson Bay Company, and more than seven thousand by the Alaska Commercial Company. With this incessant persecution, it is a marvel that otters continue to exist at all, especially as they are comparatively slow breeders. Otter-fur is used both in the natural state and when "pulled"—that is to say, when the longer hairs have been removed. When pulled and dyed, it is used largely for glove-tops, and has much resemblance to seal-skin, although it wears much better. In northern countries the darker varieties are largely used for collars and cuffs of coats in the natural undyed condition, but in England lighter-coloured skins are preferred for the same purpose.

In America, otters are chiefly captured by trapping. "Searching for a 'slide,' or place where the animal habitually crawls from the water up the bank, the hunter," writes Dr. Elliott Coues, "sets the trap on the spot, a few inches under water. No bait is here required, and devices are used in securing the trap by which the animal may be led into deep water when caught, or lifted upward, the design in either case being to prevent its escape by gnawing off the imprisoned limb. The trap may also be placed at the top of the slide, two or three feet back off the slope, in a place hollowed to receive it, and covered with snow. Under such circumstances, care is taken not to handle the trap with the bare hands. It is scented with various animal odours, and, to further ensure success, a 'way' is made to it by means of parallel logs."

The Glutton, or Wolverene. (One-sixth natural size.)

The otters constitute by themselves a separate sub-family of the *Mustilidæ*, and next to them comes in the zoological system a second sub-family represented by the skunks, badgers, and ratels. Of these, the most important from our present point of view are the skunks, of which there are several genera, all confined to America, where the range of the various kinds extends from the Hudson Bay territory to Patagonia. The species of most importance, from a commercial point of view, is the common skunk (*Mephitis mephitica*) of North America, which may be compared in size to a small cat, and ranges from Hudson Bay to the Central United States. In common with its kindred, this skunk has a large bushy tail, frequently carried bent over the back in a somewhat squirrel-like fashion, and a beautiful jet-black fur, varied with a larger or smaller amount of white forming a pair of longitudinal stripes on the body and head, and more or less of the tail. In some specimens the white is reduced to a fork on the head and a patch on the tail-tip, and it is not improbable that absolutely black examples may occasionally be met with.

White skunks are rarely found. All skunks enjoy an unenviable notoriety on account of the noisome fluid they have the power of ejecting when irritated; and it is doubtless the consciousness of the safety thus enjoyed that emboldens them to walk about in the open in broad daylight, as they may not unfrequently be seen to do on the Argentine pampas. There are, indeed, few animals that will face a skunk; and although some dogs will "go for" them, they suffer many hours' misery in consequence of their temerity. Indeed, so lasting and disgusting is the odour of the secretion of these animals, that it is by no means an uncommon event for a whole camp to be thrown into disorder at the cry of "Skunk!" It might naturally be supposed that the skin of an animal producing such an ill-favoured odour would scarcely be suited to the purpose of the furrier; but if the creature can be killed without discharging its secretion, or be made to discharge it in such a way that it does not touch the fur, the value of the latter is not impaired. And it appears that the secretion cannot be discharged when the animal is raised from the ground. Consequently, one of the best kind of traps for skunks is the so-called "deadfall," in which one huge log is made to fall suddenly upon an underlying one in such a manner that the unfortunate victim is pinned between the two and instantaneously killed. Even, however, in the manufactured state there is a suspicion of an unpleasant odour about skunk-fur, which detracts considerably from its value. Probably with a view to conceal its real nature, skunk-fur is, or was, termed by the trade "Alaska sable." The trade in these skins has greatly increased in volume during the last few years, over twelve thousand having being sold by the Hudson Bay Company alone in the year 1891. The price of what is called a black pelt varies from seven to ten or even thirteen shillings; while such pelts as have broad white stripes fetch from two to seven shillings, the whiter specimens being of still less value. Black skins are used in their natural colour, whereas all the striped ones are generally dyed black or brown; but it seems a pity that these are not made up as they are, since the contrast of the black and white would present a very striking effect. The smaller skunk *(Spilogale putorius)* of North America, which differs from other members of the group in its arboreal habits, yields skins of no great commercial value, although from six thousand to thirteen thousand are annually imported. These vary in price from sixpence to two-and-threepence each, and are commonly employed as coat-linings. Of still less value are the pelts of the South American skunk (*Conepatus mapurito*), the fur being coarse and harsh. Still, a few thousand skins are annually imported into England, and sell at from a shilling to half-a-crown a-piece.

Of the other members of the sub-family, the common badger (*Meler taxus*) is important in that its hair is largely employed in the manufacture of brushes, although it is too coarse to be much used as fur. It is estimated that about four thousand badger-skins are imported yearly into this country alone; and although we are accustomed to regard the badger as a comparatively rare animal, the fact that over five thousand head were killed in Prussia during the winter of 1885-6 shows that this is by no means the case on the Continent. According to quality and demand, the price of badger-skins fluctuates between one and two shillings each.

The North American badger (*Taxidea americana*), which differs from the true badger in the structure of the skull and teeth, has a finer coat than the latter, and is thus better adapted to the requirements of the furrier. Its general colour is light grizzled yellowish-grey, with longer black hairs, which are white at the tips; while the soft under-fur is light brown, becoming drab near the roots. The pelts are of some value, varying from about six to twenty-two shillings each. In the year 1891, between four and five thousand skins were sold by the Hudson Bay Company, and over five thousand by other traders. Occasionally the fur is dyed dark brown, although more frequently employed in the natural condition. Formerly, the hair was much used for shaving-brushes, but it is generally too soft to make good ones. Like its Old World cousins, the American badger lives in burrows, which in some parts of the country are extremely numerous, and it is endowed with the same fighting powers.

Those near allies of the badgers, the Indian and African ratels *(Mellivora)*, have fur of but little commercial value, although a few skins are imported with those of Asiatic badgers. Another member of the same sub-family is the Cape polecat (*Ictonyx zorilla*), whose black-and-white-striped pellage recalls that of the smaller skunks. In spite of the beauty of the fur, but few skins are imported into Europe; the average being only a few hundred yearly, and the price of them varying from fivepence to sevenpence each.

Much more valuable is the pellage of the wolverene, or glutton (*Gulo luscus*), which belongs to the same sub-family as the martens, and is one of the few mammals common to the northern parts of both hemispheres. The wolverene is an animal with somewhat the appearance of a small bear, although furnished with a moderately long and bushy tail. The general colour is dark grizzled brown, but a saddle-shaped area on the back is defined by a ring of lighter-coloured hair, and in some examples the whole pellage is very light-coloured. Although somewhat coarse, the long and rich fur of the wolverene has a considerable commercial value, good skins fetching as much as thirty shillings. In 1868 the Hudson Bay Company disposed of eleven hundred wolverene pelts, and a little over a thousand in 1891. A number of skins sewn together make a very handsome carriage-rug; and by the North American Indians and Eskimo, strips of wolverene-fur are employed to trim their garments. When dyed black, the fur is very handsome.

Science Notes.

A number of the former students of Professor Bonney's geological classes in the University of Cambridge and at University College, London, having felt a desire to recognize the value of his services to geological science, have united in presenting him with his portrait as a mark of their personal esteem and gratitude. The work has been executed by Mr. Trevor Haddon, Slade Scholar and Medallist, and Fellow of the Herkomer School.

The Society for the Protection of Birds has an excellent scheme for imparting a knowledge of birds and their uses to the public. The Society has provided itself with a most beautiful series of lantern slides, which it is ready to lend to any of its members for the purposes of an illustrated lecture on birds and their protection. The slides are accurate and exceedingly good, no expense having been spared to make them so.

The analysis of earths from various places in the Lower Congo district proves that the soils there, sandy as well as calcareous, are provided with reserves of phosphoric acid and potash which insure a high fertility. It is regarded as certain that, in the territories where the disappearance of forests has not modified the rainfall, the cultivation of coffee, cocoa, and other economic plants can be carried on for a long time without the use of manure.

XUM

On St. Andrew's Day, Lord Kelvin delivered his retiring address as President of the Royal Society. Referring to the losses of members sustained by the Society during the past year, he mentioned Cayley, one of the makers of mathematics; Franz Neumann, one of the most profound and fertile of all the workers in mathematical physics of the nineteenth century; Huxley, a man who can ill be spared, a resolute and untiring searcher after truth, and an enthusiastically devoted teacher of what he learned from others and what he discovered by his own work in biological science; Louis Pasteur, who, before he entered on his grand biological work, made a discovery of first-rate importance in physics and chemistry—the formation of crystals visibly right-handed and left-handed from one solution—and who, by the line of research to which he devoted most of his life, conferred untold benefits on humanity and the lower animals. Lord Kelvin went on to describe the further work on the nature of argon, and the discovery by means of spectrum analysis of a new element identified with the one called helium, found thirty years before to exist in the sun. After dealing with the awards of the various medals—the Copley medal to Dr. Karl Weierstrass for his investigations in pure mathematics, Royal medals to Dr. John Murray for his editorship of the report of the *Challenger* expedition and to Prof. Ewing for his investigations on magnetic induction in iron and other metals, and the Davey medal to Prof. Ramsay in recognition of his work on argon and helium—Lord Kelvin concluded by referring to the keen regret which he felt that the five years during which he had presided were past, and that he ceased to be the President of the Royal Society.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

VARIABLE STARS.

To the Editors of KNOWLEDGE.

SIRS,—The statements in my note in June (1895) KNOWLEDGE, as to the variations in period and fluctuations in light of Mira and R Leonis at their last appearance, having been fully verified by the observations of Mr. H. M. Parkhurst, of Brooklyn, New York, published in the *Astronomical Journal* of June 2nd and August 5th, and by your own correspondents, Messrs. Corder and Backhouse, to whom my thanks are due, that question may be regarded as settled, and in a way very gratifying to the present writer.

And now, with your permission, I will inquire what has been the experience of observers on your side with R Scutum Sobieski this season. The star has long been observed, and, like those mentioned above, is regarded by the professionals, and those having large telescopes, as a "chestnut," and is neglected. But if there is any relation between variable stars and cometary and other random things, as is supposed, their observation by careful observers with small apparatus may lead to important results.

The magnitude of R Scuti, as given by Webb, vol. ii., is at maximum 4·7 to 5·7, at minimum 6 to 9. The Companion gives the following ephemeris:—Minimum July 6th, maximum August 6th; minimum September 11th, maximum October 16th. The minima, according to Webb, are alternately bright and faint, and Klein says the period is irregular. I took up the star, and estimated its light by comparison to be—July 25th, 5·7 magnitude; August 6th, 5·8; August 21st, 5·7; August 23rd, 5·6; September 5th, 6·2; September 13th, 6·5; September 22nd, 7·00; October 4th, 7·5; October 5th, 8·0; October 8th, 8·0; October 10th, 7·8; October 12th, 7·6; October 14th, 7·5; October 15th, 7·4.

From these observations it appears that the star is behind time in period as well as in light, and that the light fluctuates. Of the four stars, *b*, *c*, *d*, and *e*, east of it, R has been the faintest since October 1st; *d*, by photometric measure, is 7·17 magnitude, falling below over half a magnitude on October 5th.

Memphis, Tenn., U.S.A. DAVID FLANERY.

SECOND BLOOMING OF THE HOLLY.

To the Editors of KNOWLEDGE.

SIRS,—Among the many second flowerings resulting from the exceptional clemency of the past autumn is one which I have never noticed here before, viz., that of the holly. This district forms part of the high plateau of the Midlands, and our well-known holly woods stand upon so high an elevation as to be exposed to winds from every direction. Nevertheless, a second flowering has occurred this autumn. I found one tree to-day bearing both the red berries from the spring blooming, and a second and plentiful crop of partially opened flower-buds.

ALFRED J. JOHNSON.

Boldmere, Sutton Coldfield,
December 8th, 1895.

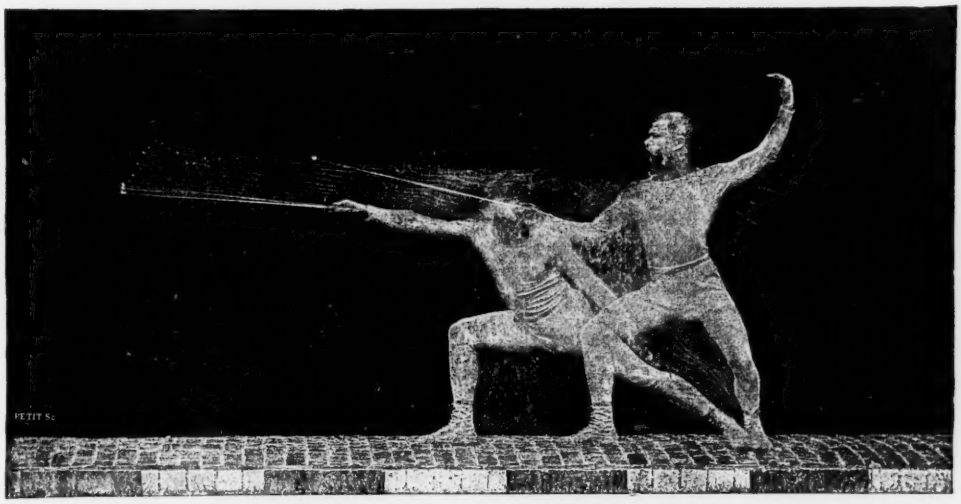
Notices of Books.

Notes on the Nebular Theory. By William Ford Stanley, F.R.A.S., F.G.S., &c. (Kegan Paul.) Illustrated. Although much has been written in support of the nebular theory of Kant and that of Laplace, few original thoughts have been added to it, and quantitative data have been markedly deficient in connection with the subject. There is little doubt that celestial bodies can be arranged in regular order, from nebulæ, "without form and void," through symmetrical nebulæ like Andromeda into stars connected with streams of nebulosity, and then into the finished product; and the form of a nebula in any particular stage of its development is probably the result of the action of gravitation upon it while in the preceding one. But this arrangement is only a scenic one; and though the spectroscope helps very considerably to define the order of celestial evolution, much yet remains to be done in determining the mathematical and physical conditions which lead to the observed differences in structure. Mr. Stanley has treated the subject in a philosophic manner, and his contribution deserves serious attention. It is difficult to trace his arguments in the short space of a review, but we may say at once that they bear the impress of original thought. To begin with, Mr. Stanley points out that the full consideration of the nebular theory requires the existence of a more attenuated form of gaseous matter than the nebulæ. This material he terms the *pneuma*, which he supposes to have pervaded all space, to contain all the chemical elements, and to represent the state of infinite diffusion proposed by Helmholtz. It is suggested that the mode of condensation which renders nebulous matter visible to its extreme outlines is purely chemical, and takes place within the exterior surface of the nebula only. Chemical action is, indeed, believed to cause the degradation of the pneuma to a gas or a nebula. Having traced what he considers to have been the mode of formation of stellar and solar systems from the original

pneuma, Mr. Stanley puts forth some ingenious speculations on the formation of orbits, and discusses the conditions upon which our solar-planetary system may have been formed, giving also suggestions for causes of direction of rotation and revolution of the planets and satellites. Finally, several chapters are devoted to the study of the hypothesis of the formation of the earth under purely nebular conditions. We have only been able to give the barest outline of the book, but it will suffice to show the character of the contents. Speculative the book undoubtedly is, but it is suggestive also; and though some of the ideas developed have little or no foundation in fact, they are worth consideration, while, taken altogether, they will help to place the study of the nebular theory upon a broader basis than heretofore.

Heligoland as an Ornithological Observatory. By Heinrich Gätke, C.M.Z.S., &c. Translated by Rudolph Rosenstock, M.A. (David Douglas.) Illustrated. 30s. For the last fifty years, day after day and night after night, as Mr. Harvie-Brown says in his preface to this deeply interesting work, Herr Gätke has studied the migration of birds. As is now generally known, the island of Heligoland is peculiarly suited to be an ornithological observatory. It stands, as it were, as a stepping-stone across the North Sea, both from east to west and from north to south. Very few birds breed on the island, but from January to December, with little cessation, vast multitudes of birds cross and recross it on migration. Each month brings new arrivals with the utmost regularity. Some sweep over without alighting; others stay a few hours, but seldom beyond a day. An uninterrupted spell of east wind combined with frost and snow brings the greatest numbers; then they appear, says the author, in "countless multitudes. . . . Indeed, I have known days on which I have seen, far as the eye could reach, in all quarters of the sky, swarms of these birds crossing each other in all directions. . . . In fact, the whole vault of heaven was literally filled to a height of several thousand feet with these visitors from the far North." Herr Gätke is no romancer—he deals with hard facts, and his observations will be invaluable to the student of migration. He discounts many theories by his facts, and he believes that the phenomenon of the migration of birds will never be fully explained. The direction, altitude, velocity, and order of migration flights are all dealt with by the author in a masterly and graphic manner, and a chapter on "Meteorological Conditions which influence Migration" is deeply interesting. Herr Gätke's remarks on the change of colour in birds without moulting will prove invaluable as an addition to our scanty knowledge of this subject. The larger portion of the book is taken up with excellent descriptions of the three hundred and ninety-eight species of birds which the author has collected on Heligoland; but by far the most fascinating and valuable portion is that dealing with their migrations. We may add that the translator has done his work well in preserving the graphic and logical style of the original.

Movement. By E. J. Marey. Translated by Eric Pritchard, M.A. (Heinemann). Illustrated. 7s. 6d. "Le Movement," the original of this book, which has been very successfully translated by Mr. Pritchard, is one of the most recent and important works of M. Marey, the eminent French physicist. By the aid of chrono-photography in conjunction with many clever devices, the author has been enabled to explain and elucidate in the book before us many of the complicated movements in man, quadrupeds, birds, fishes, creeping things, and even microscopical organisms. M. Marey's experiments have been carried out for the most part at the Parisian Physiological Station, where unique opportunities were granted to him. How well he has used those opportunities may be seen in the study of his book, which will afford interesting and instructive reading to everyone, and a mine of facts for specialists to work upon. The value of the process of chrono-photography in analyzing movement may be gathered from the fact that sixty images of a moving object can be produced per second, and thus every stage of its action can be traced. This book contains many reproductions of such photographs and numerous diagrams, important and useful to all in elucidating the text, besides being of great value to the artist for correctly depicting living creatures in movement.



A Sword Thrust. (From a Chrono-photograph on a fixed plate.) From "Movement."

Nature versus Natural Selection. By Charles Clement Coe. (Swan Sonnenschein.) 10s. 6d. Men of science are almost of one mind as regards the main fact of organic evolution, but they are not in unison as to the process by which the result has been brought about. The great

majority of scientific men believe that natural selection is the main agent in the transmutation of species. According to this doctrine, the selecting power is the struggle for existence, which secures the survival of the fittest to live and transmit their species under any given environment. Mr. Coe is among those who doubt that natural selection has been the principal agent of organic evolution. "The object of this work," he says, "is to show that natural selection *thus defined* has no place in the world of nature; that if it did exist, other factors of evolution would anticipate its action in the transmutation of species now going on; and last, but not least, that we have no definite proof of its action in the early stages of organic evolution." We must say that Mr. Coe sums up the case in a remarkably fair manner. He has evidently read practically everything that has been written on the subject, has judiciously weighed the evidence, and has found it wanting in some respects. Whatever the apostles of natural selection may think of his judgment, we are of the opinion that his impartial criticisms deserve the fullest consideration.

Hints on Reflecting and Refracting Telescopes, and their Accessories. By W. Thornthwaite, F.R.A.S. 6th Edition. (London: Horne & Thornthwaite.) 1s. An exceedingly useful little book for anyone possessing a telescope or intending to purchase one. The "hints" supplied are just of the character required, and are brief but clear. That it should have attained a sixth edition shows that it has already been much appreciated; and as it has been carefully revised in the present edition, and a considerable amount of valuable matter added, particularly with regard to the micrometer, the transit instrument, and celestial photography, it should meet with a very cordial reception from all astronomical amateurs.

A Handbook to the Birds of Great Britain. By R. Bowdler Sharpe, LL.D. Vols. I. and II. (W. H. Allen.) Illustrated. 6s. each. These volumes from the pen of the editor of Allen's Naturalists' Library will, with two others as yet unpublished, include a description of every bird which has been found in Great Britain. Dr. Sharpe has handled his subject in a masterly style, and the volumes would be of still greater value were there not so many standard works available—some more compact and others more extensive—on the same subject. In the preface to the second volume the author discusses at length the much-vexed question of nomenclature. In this Dr. Sharpe holds his own views, which differ from many other writers'. The sooner the whole question is finally settled by an international conference the better it will be for everyone concerned. A few of the coloured illustrations in these volumes are very good, but most of them are exceedingly poor. When originally issued with the first Naturalists' Library they were, no doubt, the best obtainable; but they will not pass muster when compared with more recent productions.

The Planet Earth. By Richard A. Gregory, F.R.A.S. (Macmillan & Co.) The object of Mr. Gregory's attractive-looking little text-book is to present to students "the facts relating to the earth's movements and place in the universe" in a scientific manner. "Celestial phenomena must be observed before the theories that explain them can be properly understood," and Mr. Gregory hopes that his book may "help to revive the observational astronomy of pre-telescopic times." Such a programme is a most excellent one, and to a certain extent Mr. Gregory has carried it out with considerable success. His style is lucid and pleasing, and the diagrams and illustrations he supplies are clear and good. Yet we fear that he comes short of his ideal. His first words are a reminiscence of the unscientific method he condemns; the statement that "the earth is a speck in the infinite ocean of space" precedes the observations on which this inference is based; indeed, they do not enter into the scope of the book at all. The phases of Venus are instanced as a proof of the Copernican system; they, of course, only demonstrate that Venus is a satellite of the sun, not of the earth—a view held centuries before the telescope was invented. It is not easy for the townsman born and bred to enter into any appreciation of the "observational astronomy of pre-telescopic times," he is too far removed from them, and Mr. Gregory writes like a townsman. As an attempt to put the teaching of elementary astronomy on an observational, or, as Mr. Gregory would call it, a "scientific" basis, or, indeed, as an attempt to improve on the methods adopted in our best known text-books, we fear Mr. Gregory's volume is a failure. As a brightly written little manual on an important portion of the first of sciences it is to be heartily recommended.

A Text Book of the Principles of Physics. By Dr. Alfred Daniell, M.A., &c. 3rd Edition. (Macmillan.) Illustrated. 21s. Here we have a volume for the serious student of physics; not merely a useful compendium of physical facts (like Ganot's "Physics," for instance), but a connected account of the leading principles of modern physical science, containing nothing but what should be known and understood by all who profess and call themselves physicists. To the lay mind the treatment may appear too strict and mathematical at first sight, but a closer inspection of the contents dissipates the apparent difficulty, and shows that an elementary acquaintance with mathematics is quite sufficient to comprehend all the principles described. No preliminary knowledge of these principles is assumed; the descriptions are wonderfully clear, and there is a gradual progression from the simpler to the more complex parts of the subject. We have no hesitation in saying that the author presents the modern aspect of natural philosophy as it ought to be presented—that is, in the light of dynamics and the law of the conservation of energy. For this reason we cordially commend the work to all who are able to assimilate and appreciate the truths of physics.

SHORT NOTICES.

Photograms of '95, compiled by the editors and staff of the *Photogram*, is a pictorial and literary record of the best photographic work of the year. The volume contains a number of excellent reproductions of very beautiful photographs.

A finely illustrated—both in colour and in pen and ink—edition of Shakespeare's *Merry Wives of Windsor* has just been issued by Messrs. Raphael Tuck & Sons.

The Children's Shakespeare, also well illustrated, and published by the same firm, is a collection of abstracts from Shakespeare re-written in the form of stories for children.

Old Farm Fairies, by H. C. McCook (Hodder & Stoughton), was written, the author tells us, some twenty years ago. Mr. McCook is an authority on American spiders; but in this book he throws science aside, and tells, in a way that will interest every child, of the doings of spiders, under the garb of "pixies." The book is profusely illustrated with quaint pen-and-ink drawings, some of them being the work of children.

A Popular History of Animals, by Henry Scherren (Cassell), written for young people, aims at wakening an interest in the observation of the habits of animals. The book, which is concisely and clearly written, is free from all technicalities, and, considering the great number of subjects treated of, it is remarkably free from error. The coloured plates and a large number of engravings, although not altogether good, admirably serve their purpose.

Physiology, by A. Macalister, LL.D., M.D., F.R.S. (S.P.C.K.), one of the series of Manuals of Elementary Science, presents, in a condensed form, the elementary principles of the physiology of man. It will be found of great value as a first book to the student of physiology, besides being very useful to everyone as a book of reference.

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ITALIAN RENAISSANCE MEDALS.

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BOOKS RECEIVED.

Prehistoric Man in Ayrshire. By John Smith. (Elliot Stock.) Illustrated. 12s. 6d.

The Wild-Fowl and Sea-Fowl of Great Britain. By A Son of the Marshes. Edited by J. A. Owen. (Chapman & Hall.) Illustrated. 14s.

Birds from Moidart and Elsewhere Drawn from Nature. By Mrs. Hugh Blackburn. (David Douglas.) Illustrated.

Euclid's Elements of Geometry. Edited by H. M. Taylor, M.A. Books 1-6, 8, 11-12. (Cambridge University Press.) 5s.

Molecules and the Molecular Theory of Matter. By A. D. Risteen. (Quin & Co.) Illustrated. 8s. 6d.

The Housing of the Working Classes. By Edward Bowmaker, M.D. (Methuen.) 2s. 6d.

Principles of Metallurgy. By A. H. Hiorns. (Macmillan.) Illustrated. 6s.

First-Stage Mechanics. By F. Rosenberg, M.A. (University Correspondence College Press.) 2s.

Practical Inorganic Chemistry. By G. S. Turpin, M.A., D.Sc. (Macmillan.) Illustrated. 2s. 6d.

An Almanack for 1896. By Joseph Whitaker, F.S.A.

Dynamo Attendants and Their Dynamos. By A. H. Gibbings. 2nd Edition. (Rentell.) 1s.

Annuaire Astronomique pour 1896. Par Camille Flammarion. Illustrated. 1fr. 25c.

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ITALIAN MEDALS.

By G. F. HILL.

IT has long been customary to speak of coins and medals* together as if they were but species of the same artistic genus; and, in so far as method and technique go to constitute a work of art, the connection is to some extent justified. But the objects for which the two things are produced are, it is needless to insist, totally different. It has been usual to speak of certain Syracusan coins as "medallions," but the only excuse for the term is the unusually showy and magnificent character of their design. The beautiful gold piece of Eucratides, King of Bactria, now at Paris, may be meant for a medal; but its weight is equivalent to twenty staters, and it must therefore remain in the doubtful class. Certain "show-coins" struck in Germany at various times cannot be classed with either species exclusively, for they could be accepted as current coin. But if these are medals, they are exceptions to the general rule that the medal is not meant for circulation as a medium of exchange, and should be regarded purely as a piece of metal work. The Roman medallions, which were mentioned in a former paper, are real medals, and were only considered along with Roman coins for the sake of convenience.

In the matter of medals the Italians hold that pre-eminent position which belongs to the Greeks in coins.† Like all the rest of the art of the early Renaissance, the early medallic art of Italy, while stimulated and inspired by the art of Rome, is by no means a mere imitation. It is as distinctively Italian as the sculpture and painting of the nation. Unlike the art of Greek coins, however, the medallic art of Italy sprang into being fully developed, and went through no primitive stages like its sister, sculpture. Sculpture of very considerable merit had existed in Italy since the thirteenth century; but it is not until the middle of the fifteenth century that the medal can be said to be established as a work of art in Italy; for a few exceptional pieces of earlier date need not be considered. In 1380 there was born at Verona, Vittore Pisano, or Pisanello, of whom it may be said that had Italy produced no other medallist she would still have stood at the head of the art. In all essentials Pisano shows more power and more originality than any of his successors. The medal is in the majority of cases, at least in Italy, commemorative of a person; portraiture, therefore, is an essential element, and such portraits as those of Leonello, Marquis of Este (Fig. 3), or the Spaniard, Don Inigo d'Avalos, Marquis of Pescara (Fig. 1), need no praise. These two have been chosen for illustration because they show the same hand working in two utterly different ways. The Italian ruler's bust is in high relief; the features are modelled with extraordinary boldness and even severity. There is nothing redundant, only just sufficient ornament about the bust to prevent the total effect being bare. With such a treatment of the head, Pisano has rightly avoided the bare bust. But contrast with this the soft treatment of the other portrait; the delicate features raised in the shallowest relief from the surface, and shaded by the broad hat, with the drapery sweeping down in bold lines to frame the face. Here nothing could be softer or less severe than the treatment of the flesh, and with it all there is no lack of decision.

Pisano seems to have stood alone among his contemporaries for the beauty of the reverses of his medals no less than for his skill in portraiture. As a specimen we may notice here the reverse of a medal of Alfonso V., King of Aragon and the Two Sicilies (Fig. 2), which represents the king as a boy hunting the boar. Nothing can be finer than the action of the piece. The boar is held by the left ear by a hound; the king has seized it by its other ear and is about to plunge his sword into its flank. Behind is seen the tail of a second dog, and there is a rocky background. Above is the legend VENATOR INTREPIDVS. The slight figure of the boyish king contrasts with the huge mass of the boar, and brings out all the meaning of the epithet. Pisano was famous for his delineation of animals; and the loving care with which he renders details, and the way in which he loses no opportunity of introducing an animal into a scene, remind us of Dürer. Zoologists will perhaps find something to blame in Pisano's, as in Dürer's, animals. But this need not detract from our praise of their picturesqueness and liveliness. The paintings of Pisano are very rare, but the National Gallery possesses two, one of which, "The Crucified Christ appearing to St. Eustace," should certainly be studied in connection with his medals.

Pisano's pre-eminence must justify the space here devoted to him at the expense of his successors. Of these, two must be mentioned here: Matteo Pasti, of Verona, and Sperandio, of Mantua. The former was actually a pupil of Pisano, and it is possible to trace a resemblance in style between the work of master and pupil. The bust of the celebrated condottiere, Sigismondo Pandolfo di Malatesta (Fig. 4), is as fine as anything by Pisano himself.* The reverse of Pasti's medal gives a view of Sigismondo's castle at Rimini. The representation of a building is a feat which almost every medallist thinks within his power,

* The term "medal" was, until the present century, used indifferently for coin (when regarded as a curiosity or preserved in a collection) or medal—more frequently the former. It is now restricted in English to mean the commemorative piece, though often used by journalists to translate the French *médaille*, when that word should be rendered "coin."

† See "Coinage of the Greeks," KNOWLEDGE, June, 1895, and "The Coinage of Rome," November, 1895.

* "This man," says Symonds, the historian of the "Renaissance in Italy" (Vol. I., p. 157), is "a true type of the princes who united a romantic zeal for culture with the vices of barbarians." The last phrase is hardly strong enough for the villanies which Sigismondo committed, and with which his face, as here depicted, is in thorough keeping. His portrait was also made by Pisano, and the medals should be compared with the splendid relief on the base of a column in the cathedral at Rimini.

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if we may judge by the number of attempts; but it is hardly too much to say that Pasti has succeeded in adapting the view to the allotted space, and in catching the true perspective of the rugged keep and towers, where ninety-nine out of a hundred would have failed.

Sperandio of Mantua worked in the latter half of the fifteenth century, and stands some way behind the two artists already mentioned, except in the excellence of his portraits. It will be sufficient to notice his bust of Federigo del Montefeltro, Duke of Urbino (Fig. 5).* The reverse of the medal, representing the duke on horseback, is vigorous, but the proportions of the figures are not as good as they might be. Before leaving this period we may notice another portrait, that of Giovanni Tornabuoni (Fig. 7). Unlike the men already mentioned, Tornabuoni was a peaceful citizen of Florence, of one of that city's most distinguished families. The modelling of the face, and notably the delineation of the eye, is excellent. The reverse, which is remarkable for its fine simplicity, represents Hope looking up at the symbol of the Trinity.

It has been rightly remarked that there is a distinct line traceable between the work of the fifteenth century and that of the sixteenth. We pass in A.D. 1500 from a series of medals which are, as a rule, large in size, simple in treatment—in fact, so many small pieces of sculpture in relief—to a series which are smaller in size, more elaborate and sometimes even finicking in treatment, and frequently under the influence of painting.† There is, in fact, a difference between the medallic work of the fifteenth and sixteenth centuries more or less parallel to that between Greek sculpture of the fifth century and the work of the age succeeding Alexander the Great. Great skill in pure technique goes side by side with, or, rather, is the cause of this change in character. The number of medallists naturally becomes larger: Francesco Francia, the painter; Benvenuto Cellini, the sculptor and chaser; Valerio Belli, Annibale Fontana, Lione Lioni, Pomedello, Pastorino of Siena, Cavino the Paduan, Federigo Bonzagna, are only a few of the more famous names. Some of these artists did work which in style cannot be strictly separated from that of their predecessors of the fifteenth century. A good instance is the portrait by Pomedello of an unknown lady (Fig. 6). On the obverse, the simplicity of treatment, the partition of the relief into masses contrasting sharply with each other and with the background, and not fading into each other, is characteristic of the earlier period. When we analyse the relief we find it to consist of three main parts—face, hair, and bust, the throat being subordinate in effect. Yet, in spite of this clear demarcation of parts, the whole relief is perfectly harmonious, and no part is treated so much in detail as to draw the attention away from the rest. This simplicity, one might almost say *naïveté*, of composition becomes rarer as time goes on. The reverse of this very medal, finely conceived as it is, seems to belong to another period in its elaborate richness of design and crowded field. Pomedello, then, is to be regarded as representing the transition from the fifteenth to the sixteenth century.

A famous medal by Annibale Fontana, who died in 1587, and is also known as a sculptor and gem engraver, takes us further on into the style of the sixteenth century. The portrait is that of another and later d'Avalos, Marquis of Pescara, a well-known general and author. The work errs by over-elaboration, particularly as regards the drapery of the bust, in comparison with which the head is almost insignificant. The reverse (Fig. 8) represents Hercules, with his foot on the dragon, plucking the apples of the Hesperides. An elaborate landscape, with the sun rising over a city, is seen in the background. The detail is admirable, but out of place; the fine proportions of the main figure only lose by being set against such a background. In a painting—and it is a painting which the work suggests—that background could have been made to take its proper place; in a relief, the absence of colouring makes this impossible. The "pictorial" treatment of a subject in a relief may lend it considerable charm; but the artist here has not understood the limits of his art. The unknown maker of the medal of Antonio de Leyva (Fig. 11) has succeeded better. In this piece there is not the same discord between the figure of Fame in the foreground, and the landscape—hardly less elaborate (considering the smaller size of the medal) than that of Fontana—behind it. The portrait of De Leyva, again, is a beautiful example of the pictorial treatment of a bust. Its date is some time between 1533 and 1536.

One of the most prolific of portrait medallists in this age was Pastorino de' Pastorini, a native of Siena. A large number of his medals have no reverse, and the character of the obverses hardly leads us to expect any great originality in design. The portraits are admirably finished, but, as in the work of most artists who devote themselves chiefly to portraiture, they tend to become a little mechanical. One of his most pleasing busts is that of Buonaventura di Gruamonte (Fig. 9), dated 1557. Pastorino died about 1591.

There is one class of Italian medals which has been a source of considerable trouble to collectors of Roman coins; these are the so-called "Paduans." It was at Padua that the earliest known Italian medals were made in 1390, and at this ancient university city lived Petrarca, the first man who is known to have collected Roman coins. In 1390 the lords of Padua had two medals struck bearing their likenesses, but in style resembling Roman bronze coins; but the medals known especially as "Paduans" are the careful imitations made by Giovanni Cavino and Alessandro Bassiano in the sixteenth century. Very often these imitations are so skilful that only an eye long experienced in the Italian style can distinguish them from originals. The difficulty is sufficiently illustrated by the Paduan medal of Agrippina the Elder (Fig. 13), which we give side by side with the Roman coin from which it is copied (Fig. 12). Differences in the lettering, in the metal, in small details of every kind, but, above all, in the general feeling of the composition, have to be considered in order to decide between Paduan and Roman. Broadly speaking, the Paduan is the more elegant, the Roman the stronger piece of work.

The interest of all the medals which we have described so far has been almost purely personal. Only a few Italian medals can be cited which refer to events of a more historical interest. Of these, the best known—at least, in Protestant countries—is, without doubt, the medal struck under Pope Gregory XIII. in 1572 in commemoration of the Massacre of the Huguenots (Fig. 10). The destroying angel is represented advancing with sword and cross against the Huguenots. The medal, which is not otherwise than historically interesting, is by Federigo Bonzagna.

* Federigo is one of the too rare redeeming characters of his age; an enthusiastic patron of the arts and sciences, a general unrivalled in the art of war as it was understood in his day, a plain dealer; in fact, a model prince, and none the less a model husband.

† As Keary (*British Museum Guide to the Exhibition of Italian Medals*, p. xi.) remarks: "At the beginning of the fifteenth century the early school of Italian sculpture reached its highest point of beauty in the hands of Ghiberti (1376-1455), and of Donatello (1386-1466). . . . After the time of Donatello the painters deservedly outweighed the sculptors as a body in public estimation."

The changes in style which we have described are, as we have said, accompanied and partly caused by a change in technique, which we may now proceed to consider. The early Paduan medals were struck from dies, like the coins of the period. But from 1390 onwards for nearly a century very few medals were struck. The workmen who cut the coin-dies of the period could only work in low relief, and it was difficult to make dies which would stand the strain of being struck on large masses of metal. The result was that most of the medals of the fifteenth century were cast by the *cire perdue* process. It was thus possible to obtain large pieces in high relief, a relief which it would be difficult to obtain even with the hydraulic press of the modern medallist. The use of the casting process left the artist a free hand in design; he modelled the two sides of the medal in wax, instead of painfully engraving the dies for them on some hard metal. The soft material naturally enabled him to work boldly and in high relief. The wax models were then impressed in some casting material—fine sand or charcoal—and the two sides placed together. The wax having been melted out, the mould was complete. The first proofs were often taken in gold or silver, but extant specimens in these metals are excessively rare; some of those supposed to be originals are apparently later casts. The ordinary medal was cast in bronze or lead. The latter metal was probably used because of the low temperature at which it melts, as well as because of its softness. This was an important quality when the process of casting was employed, because any roughness and inequalities left by the mould had to be removed with the chasing tool. From one of the original medals moulds could be made, and in this way old medals were reproduced down to a late date. These later pieces are somewhat smaller than the older ones, owing to the shrinkage caused by cooling, and, of course, the later the copy the worse the style.*

Early in the latter half of the fifteenth century there was born at Venice, Vittore Gambello, better known as Camelius. He was a goldsmith, a sculptor, and an engraver of coin-dies, as well as a medallist. He was popularly supposed to have been the first to strike medals, but, as Friedländer† has shown, and as we have seen, medals were struck at a very much earlier period. What he did was to bring the art of striking to a higher degree of perfection, so that deeper relief could be obtained. He is last mentioned in 1523. In the sixteenth century almost all the medals were struck from dies. The influence of the struck medals naturally extended itself to those which were cast. Hence a smaller size, lower relief, minuter detail, and, as a rule, less bold design. The work very often resembles that of the jeweller or gem-engraver, and, as we have seen, the influence of painting was not unfelt. The influence of the change in technique may best be seen in such an artist as Pastorino, of Siena, whose work we have already mentioned as showing great finish. He seems to have devoted himself to obtaining the delicacy and fineness of struck work on a cast medal, and to have done so with success, for it is sometimes hard to believe that his pieces are not struck, so clean and sharp are they in execution.

By the end of the sixteenth century the best traditions of medallic art had become faint in Italy. A large series of medals continued to be issued, especially by the Popes, but the work is decidedly inferior. The best-known medallists are, perhaps, Antonio Moro and Giovanni Mola, who both worked in the seventeenth century. They were followed later by Otto Hamerani (1694-1768), one of the medallists of the Papal Court, who is well known as an engraver of medals for the exiled Stuart family. But long before this time we have to turn to other countries for medals that have either high artistic or high historical interest.

Those who wish to follow up the subject, of which only the barest outline has been given above, will find full information and plentiful illustrations in Friedländer's *Die Italienischen Schaumünzen des 15ten Jahrhunderts*, and Heiss's *Les Médailleurs de la Rénaissance*. These are large and costly works; but the *British Museum Guide to the Exhibition of Italian Medals* is within the reach of most purses, and its illustrations are among the best of their kind.

* Of the medals represented in the plate, all are of bronze save three (Nos. 8 and 9 of lead, No. 10 of silver). Nos. 1 to 9 and 11 are cast, the rest struck; Nos. 1, 2, 3, 4, 7, and 11 have also been chased.

† *Die Italienischen Schaumünzen*, p. 3.

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5. Federigo del Montefeltro. By Sperandio. Bronze. Cast.
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PARASITIC FLOWERING PLANTS.—THE MISTLETOE AND DODDER.

By J. PENTLAND SMITH, M.A., B.Sc.

ALL plants may be grouped into two classes, according to their possession or non-possession of chlorophyll, and the latter class is sub-divided into two groups, one of which is composed of those organisms that prey upon other living organisms, and the other of those plants which live on the dead bodies of once living beings. The name, parasite, has been reserved for the members of the first group, and the plant or animal attacked is called the host; while the members of the second are characterised as saprophytes.

Fungi (mushrooms, moulds, etc.) compose by far the great majority of parasites and saprophytes, but the flowering plants are by no means unrepresented in either category.

The most familiar example of a parasitic flowering plant is one that flourishes in England, and is much used for decorative purposes at Christmastide. The mistletoe grows abundantly in the South and West of England and on the Continent. Its stem is stout, and much branched in a regular manner. The main branch produces a flower, and further apical growth then ceases. But two lateral branches arise at the same level below the flower. These in turn bud and flower, but, before doing so, they produce two lateral branches like the parent stem. As the flowers die away it appears as if each branch had in turn divided into two branches. The evergreen leaves are lance-shaped, and they and the stems have either a dark or yellowish-green hue. Some plants bear male flowers, others bear female. Both kinds of flower are inconspicuous. The fruit is white, with a very viscid juice. It is almost universally believed that the mistletoe occurs on the oak. This tree is rarely its host; it

grows chiefly on the apple, pear, service tree, hawthorn, and occasionally on limes, poplars, willows, and firs. The accompanying illustration (Fig. 1) is from a photo-

FIG. 1.—Mistletoe growing on a Crabtree.

graph, kindly provided by Mr. Geo. Paxton, of a plant growing on a Siberian crabtree. This mistletoe is a very large one, being five feet three inches in height and fourteen feet six inches in circumference.

The young mistletoe, while still enclosed by the seed coat, contains the green colouring matter chlorophyll. This is an unusual circumstance, as chlorophyll is developed, as a rule, only in tissues exposed to sunlight; and equally anomalous is its presence in the cells of the nourishing matter surrounding the embryo. When the seed germinates, the part of it below the cotyledons, the radicle as it is termed, emerges first from the seed coat. It is immediately brought into contact with the bark of its host. "This is the case even when the seed chances to stick with the radicle of the seedling pointing away from the branch; the whole axis of the embryo curving towards the surface of the bark in a very striking manner." The radicle then presses itself against the tree, and at the same time becomes disc-shaped. Then from its centre a growth arises which pierces the stem of the host and penetrates as far as the wood. This portion is called a sinker, borer, or hau torium.

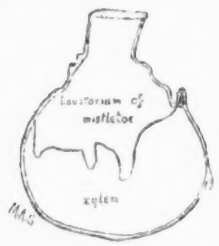


FIG. 2.—Transverse section of Thorn Acacia with Mistletoe.

It is shown in longitudinal section in Fig. 2, which is a transverse section stem of the "thorn acacia" on which a mistletoe plant has fastened itself.

Let us now glance briefly at the structure and functions of the component parts of the stem of a green plant that yearly increases in thickness, in order that we may be in a position to appreciate the relations existing between the parasite and its host. We shall examine the transverse section of the stem of the mistletoe itself, an illustration of a portion of which is given in the accompanying sketch (Fig. 3). The central part of the stem is at first occupied by a cylinder of pith (*p*), whose thin-walled cells, as a rule, become obliterated later on. Surrounding it is a zone of wood (*xy*), composed of cells and tracheæ. The cells contain protoplasm, and so are capable of further growth. The tracheæ are devoid of protoplasm. The cells act as storehouses of starch, while the tracheæ are the rapid carriers of "crude" sap from the roots to the leaves. Outside the wood is a layer or layers of cells, to whose activity is due the increase of the stem's girth. It is termed the cambium (*ca*). The cambium is enclosed by the phloëm (*ph*). In the mistletoe it appears in wedge-shaped patches in cross-section. Its constituents are ordinary cells containing protoplasm, and sieve-tubes; the latter are cells whose horizontal, and sometimes also lateral, walls are pierced by holes, giving them the appearance of sieves. The phloëm conducts elaborated food-material from the leaves to wherever growth is going on. Much of this food is of a colloid nature, and so it is necessary to provide apertures to enable it to pass rapidly from one place to another. The xylem, phloëm, and cambium are almost invariably associated the one with the other, and in young annual stems, such as the Common Sunflower, or in the leaf-stalks of the Rhubarb, form the stringy fibres so noticeable when these structures are broken across. These strings are known as the vascular bundles, and as fibrous strengthening material is often associated with them (for purposes of support) they have received the name of fibro-vascular bundles.

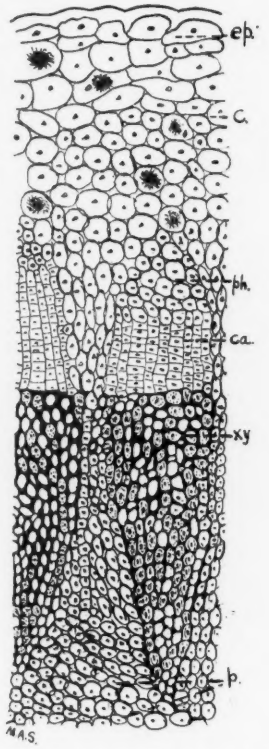


FIG. 3.—Transverse section of Stem of Mistletoe: *ep*, epidermis; *c*, cortex; *ph*, phloëm; *ca*, cambium; *xy*, xylem (wood); *p*, pith.

By the division and sub-division of the cambium cells yearly, zones of wood and phloëm are produced; but the wood increases disproportionately to the phloëm, and ultimately forms the main portion of the stem. To the tissues encircling the vascular bundles the name cortex (*c*) is applied. The outer cortical cells contain chlorophyll, and so are active in carbon assimilation. The epidermis (*ep*) is the layer of cells enclosing the cortex; its outer walls are corky, and so prevent the evaporation of slow currents of water passing from the roots to the leaves. When the epidermis becomes ruptured during

the later stages of growth, its place is taken by cork developed by the divisions of one of the outer layers of cortical cells.

Now, all these structures (with the exception of vessels in the wood) can be seen in the stem of the mistletoe. As a rule chlorophyll is present only in the outer cortical layers of a stem and in certain cells of a leaf, but in the mistletoe almost all the cells of the plant, stem, root, and leaves, are filled with the green colouring matter. The ramifications of the parasite in the tissues of the host are thus easily detected.

The haustorium, developed from the inner parts of the radicle, passes through the cortex of the host-plant until it arrives at the wood, which, however, it does not pierce. But next year we find its apex buried in it; the cambium cells of the host have developed new wood, which has surrounded the haustorial tissues. It is clear that the continued production of fresh xylem year by year would result in the destruction of the haustorium; but provision is made to obviate this. The cells situated near the apex of the haustorium of the first year divide up in such a manner as to cause it to increase in length just as much as the wood of the host increases in thickness, and simultaneously an increase in girth occurs, so that in a transverse section of the host (Fig. 2) the sinker appears wedge-shaped. It is thus manifest that year by year the haustorium becomes more deeply embedded in, and thus more intimately fixed with, the wood of the plant on which it is parasitic.

The part of the haustorium in the cortex of the host is composed of a central cylinder of numerous tracheides, surrounded by thin-walled cells densely filled with protoplasms; this is enclosed by a cortex of thin-walled cells becoming thick-walled towards the periphery. The portion of the sinker that has become embedded in the wood possesses a large number of tracheides uniting directly at its sides, but not at its tip, with the wood of the host. Surrounding these are cambium-shaped cells. In a line with the cambium of the host-plant are layers of cambial cells, from which originate lateral branches. The parasite is thus immediately connected, and very intimately, with the wood only of its host.

Now, this is just what might be expected. For the possession of such an abundance of chlorophyll renders it perfectly autonomous in the work of carbon assimilation. It is thus quite independent of its host for the carbon and oxygen necessary for the building up of protoplasm; all it requires from it are water and inorganic salts. These we know, after their absorption from the soil by the root-hairs, are carried up by the wood of the host. The intimate fusion of its wood-elements with those of the mistletoe ensures the passage of those inorganic substances into the body of the parasite.

The mistletoe is thus only a partial parasite. It merely obtains the inorganic portion of its food-supply from its host, and on it it appears to exert no baneful effect. The host, nevertheless, cannot be nourished in turn by the parasite, owing to the absence of sieve-tubes in, and the presence of thick-walled cells at, the periphery of the haustoria, bordered generally by dead phloëm cells of the host.

There are other parasitical flowering plants whose effects upon their hosts are by no means of the harmless nature of those of the mistletoe. The dodders (species of *Cuscuta*) are examples of such. They are found in all parts of the world. One of them (*Cuscuta trifolii*) attacks clover, and its ravages at times are exceedingly destructive. It is said to be a variety of *Cuscuta epithymum* that attacks thyme and allied plants. Two other species are found in the British Isles—*Cuscuta epilinum*, which, as its name implies, is parasitic upon flax (*Luium*), and *Cuscuta Europœa*, a parasite on the nettle, hop, &c. The clover dodder spreads over its host so as to leave a field of bright green clover a mass of yellowish tangled thread-like stems. The seeds of the dodder are doubtless sometimes sown along with the clover seeds. In nature they fall from their seed capsules in autumn, remain on the ground over winter, and germinate the following spring, but a month later than the majority of other plants. By the time the embryo emerges from the seed the seedling clover has attained a fair size, and plants of perennial growth have developed their young shoots. The seed contains a mass of endosperm or nourishing matter, which ministers to the nourishment of the young plant during the early stages of its growth. As in the case of other flowering plants, the root is the first part to emerge from the seed-coat, but, unlike the majority of these, it is unprovided with a root-cap, although it is clothed with numerous short hairs. The root scarcely enters the soil. Owing to its persistent parasitism, its original structure has become much altered. Its central axis no longer possesses vessels, as in other roots, to enable the rapid conduction from the soil of water containing nutritive salts, or sieve-tubes to convey elaborated sap to growing parts; but instead it consists of a cylinder of cells densely filled with protoplasm, whose elongated form gives a hint as to what would occur were the plant to live again an independent existence.

The root enters the soil or creeps along the ground for a short distance. The stem bends slightly above the surface of the soil, and circumnutation then takes place to enable it to come in contact with a support. The moisture absorbed by the root hairs, if the plant grows in a damp atmosphere, is sufficient to convert all the reserve material in the seed into forms available for the nutrition of the seedling, and the stem then grows apace and may attain a length of a few centimetres; but should the surroundings be dry its growth is materially lessened, both in length and thickness. The apex of the stem by-and-bye emerges from the seedling, and it is seen to be devoid of cotyledons or seed leaves. The root soon dies away, and the food-material contained in it is passed on to the growing part of the stem, thus aiding it to further increase in size. The basal portion of the stem also dies away, and the food material there is also conveyed to its apex. Thus, should the stem fail to come into contact with a suitable support before the death of the root, there is additional help given to enable it so to do. The direction taken by the circumnutating stem is from left to right, and the first few spirals formed are very close. This prevents the *Cuscuta* stem being thrust off the host by its own rapid growth.

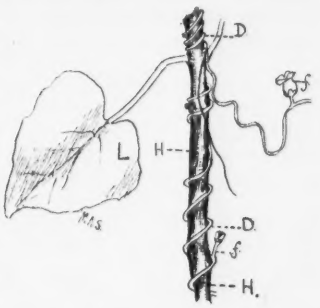


FIG. 4.—Stem with Dodder fastened to it: D, Dodder stem; *f*, its flowers; H, stem of host.

The stem bears scale leaves only, and in their axils arise flowers and branches. No chlorophyll, or, at most, the merest traces are developed in the plant; consequently it must be wholly dependent on green plants for its supply of food. Such is found to be the case, and the mode in which it obtains this we shall now inquire into.

In Fig. 4 is shown a part of the stem of a plant around which a dodder has wound itself; *h* is the stem in question, *d* the stem of the dodder, and *f* its flowers. Fig. 5 is a section of the same stem, and shows the manner in which the dodder has fastened itself to it. It may be noted in passing that when the *Cuscuta* seedling comes in contact with dry, innutritious support, it does not twine itself about it, although, as Von Mohl* notes, the same plant would encircle tightly the stem of a nettle, for instance, in nine hours. There is an obvious advantage in this, as in dry weather the support would absorb water from the slender stem. When the *Cuscuta* has once become attached to a nutritive support, it may afterwards twine round a support from which it can derive no nourishment. At frequent intervals in the close spiral where the stem is brought into intimate contact with the support, small lenticular protuberances make their appearance. The origin of these can be studied by making a number of sections through that part of the stem.

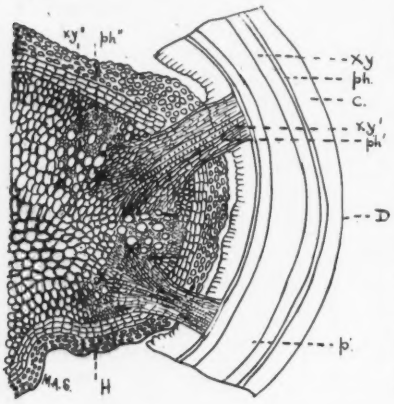


FIG. 5.—Transverse section: D, Dodder stem; H, stem of host; *xy*, xylem (wood); *ph*, phloëm; *c*, cortex; *p*, pith; *xy'*, *ph'*, xylem and phloëm of haustorium; *xy''*, *ph''*, the same of host stem.

Through the thin-walled papillate epidermal cells a ferment is excreted, which attacks the epidermal cells of the plant around which the *Cuscuta* is entwined, and ultimately dissolves them. While this is going on the haustorium is increasing in size; it dissolves its way through the overlying cortical parenchyma until it reaches the exterior. Then it passes into the host-plant by the entrance already prepared for it by the epidermal cells, and proceeds towards the centre of the stem. It eats its way through the cortical cells of its host by means of a ferment secreted by its elongated apical cells, the material of the dissolved cells furnishing it with fresh supplies of nutriment. This provides the cells situated behind the apex with energy, that enables them to increase in size and then divide up. In this manner the haustorium increases in length; the dissolution of the host-cells and its own elongation proceeding simultaneously. Should the vascular bundles of the host be far apart the haustorium grows into a medullary ray, and then develops to a greater extent laterally than apicilly, and so applies itself to one of the bundles. Should the bundles be pretty close to one another it grows equally on both sides, and thus attaches itself to both bundles. This is what has happened in the specimen figured (**Fig. 5**). The phloëm of the haustorial bundles (*ph'*) has attached itself to the phloëm of the host-bundles (*ph''*) at X, and the xylem of the haustorial bundles (*xy'*) has united with those of the host (*xy''*) at X.

There are many points of interest in connection with the relations existing between the dodder and its host, the recounting of which would take us beyond the limits of this paper.

* "Annals of Botany," Vol. viii., p. 75.

THE FACE OF THE SKY FOR JANUARY.

By HERBERT SADLER, F.R.A.S.

SUNSPOTS and faculæ are still to be observed in considerable numbers on the solar disc. Conveniently observable minima of Algol occur at 11h. 12m. P.M. on the **14th**, 8h. 1m. P.M. on the **17th**, and 4h. 50m. P.M. on the **20th**.

Mercury is an evening star, but is too near the Sun to be seen during the first portion of the month, and afterwards his great southern declination somewhat interferes with observation. On the **11th** he sets at 5h. 13m. P.M., or about one hour after the Sun, with a southern declination of 21° 7′, and an apparent diameter of $5\frac{1}{2}''$, $\frac{90}{100}$ths of the disc being illuminated. On the **21st** he sets at 6h. 8m. P.M., or one hour and a quarter after the Sun, with a southern declination of 15° 40′, and an apparent diameter of $6\frac{1}{3}''$, $\frac{66}{100}$ths of the disc being illuminated. On the **31st** he sets at 6h. 16m. P.M., or about one hour and a quarter after the Sun, with a southern declination of 11° 2′, and an apparent diameter of $8\frac{1}{2}''$, $\frac{20}{100}$ths of the disc being illuminated. He is at his greatest eastern elongation (18½°) on the **24th**. While visible he describes a direct path through Capricornus to the confines of Aquarius.

Venus is a morning star, but is rapidly diminishing in brilliancy, and her great and increasing southern declination rather militates against her successful observation. On the **1st** she rises at 4h. 21m. A.M., or about three hours and three-quarters before the Sun, with a southern declination of 17° 3′, and an apparent diameter of 18″, $\frac{65}{100}$ths of the disc being illuminated. On the **11th** she rises at 4h. 45m. A.M., or 3h. 20m. before the Sun, with a southern declination of 19° 44′, and an apparent diameter of $16\frac{3}{4}''$, $\frac{69}{100}$ths of the disc being illuminated. On the **21st** she rises at 5h. 7m. A.M., or 2h. 50m. before the Sun, with a southern declination of 21° 13′, and an apparent diameter of $15\frac{3}{4}''$, $\frac{72}{100}$ths of the disc being illuminated. On the **31st** she rises at 5h. 25m. A.M., with a southern declination of 22° 0′, and an apparent diameter of $14\frac{3}{4}''$, three-quarters of the disc being illuminated. During January she describes a direct path through Scorpio into Ophiuchus.

Mars, Saturn, and Uranus are, for the observer's purposes, invisible.

Jupiter is a resplendent object in the evening sky, being in opposition to the Sun on the **24th**. On the **1st** he rises at 6h. 5m. P.M., with a northern declination of 19° 8′, and an apparent equatorial diameter of $45\frac{3}{4}''$. On the **11th** he rises at 5h. 19m. P.M., with a northern declination of 19° 28′, and an apparent equatorial diameter of $46\frac{1}{8}''$. On the **21st** he rises at 4h. 32m. P.M., with a northern declination of 19° 48′, and an apparent equatorial diameter of $46\frac{1}{2}''$. On the **31st** he rises at 3h. 42m. P.M., with a northern declination of 20° 8′, and an apparent equatorial diameter of $46\frac{1}{2}''$. At the beginning of the month he is about ½° N. of δ Cancri, and continues a retrograde path through Cancer during the month, passing through the outlines of the scattered cluster Præsepe. The following phenomena of the satellites occur before midnight on the days named, while the planet is more than 3° above and the Sun 8° below the horizon:—On the **1st** an eclipse disappearance of the first satellite at 8h. 6m. 41s. P.M., and its occultation reappearance at 10h. 57m. P.M. On the **2nd** a transit egress of the shadow of the first satellite at 7h. 44m. P.M.; and its transit egress at 8h. 16m. P.M. On the **3rd** a transit ingress of the shadow of the second satellite at 10h. 9m. P.M., and the transit ingress of the

satellite itself at 11h. 9m. P.M. On the **4th**, at 7h. 59m. P.M., a transit egress of the third satellite. On the **5th** an occultation disappearance of the second satellite at 9h. 6m. P.M. On the **8th** an eclipse disappearance of the first satellite at 10h. 0m. 27s. P.M. On the **9th** a transit ingress of the shadow of the first satellite at 7h. 19m. P.M., of the satellite itself at 7h. 41m. P.M.; a transit egress of the shadow at 9h. 38m. P.M., and of the satellite itself at 10h. 1m. P.M. On the **10th** an occultation reappearance of the first satellite at 7h. 7m. P.M. On the **11th** a transit ingress of the third satellite at 7h. 36m. P.M.; a transit egress of its shadow at 9h. 57m. P.M., a transit egress of the satellite itself at 11h. 15m. P.M. On the **12th** a transit ingress of the fourth satellite at 6h. 43m.; an eclipse disappearance of the second satellite at 7h. 53m. 23s. P.M.; a transit egress of the shadow of the fourth satellite at 8h. 36m. P.M.; an occultation reappearance of the second satellite at 11h. 21m. P.M.; a transit egress of the fourth satellite at 11h. 26m. P.M. On the **15th** an eclipse disappearance of the first satellite at 11h. 54m. 23s. P.M. On the **16th** a transit ingress of the shadow of the first satellite at 9h. 12m. P.M., of the satellite itself at 9h. 24m. P.M.; a transit egress of the shadow at 11h. 32m. P.M., and of the satellite at 11h. 45m. P.M. On the **17th** an eclipse disappearance of the first satellite at 6h. 22m. 51s. P.M., and its occultation reappearance at 8h. 51m. P.M. On the **18th** a transit egress of the shadow of the first satellite at 6h. 1m. P.M., of its shadow at 6h. 11m. P.M.; a transit ingress of the shadow of the third satellite at 10h. 19m. P.M., and of the satellite itself at 10h. 51m. P.M. On the **19th** an eclipse of the second satellite at 10h. 29m. 1s. P.M. On the **21st** a transit egress of the shadow of the second satellite at 7h. 30m. P.M., of the satellite itself at 7h. 39m. P.M. On the **23rd** a transit ingress of the shadow of the first satellite at 11h. 7m. P.M., and of the satellite itself at 11h. 8m. P.M. In this case, and on the **25th**, the shadow may be occulted by the satellite. On the **24th** an occultation disappearance of the first satellite at 8h. 14m. P.M., and its reappearance at 10h. 34m. P.M. On the **25th** a transit ingress of the first satellite at 5h. 34m. P.M., of its shadow at 5h. 35m. P.M.,; a transit egress of the satellite at 7h. 54m. P.M., and of its shadow at 7h. 55m. On the **28th** a transit ingress of the second satellite at 6h. 58m. P.M., of its shadow at 7h. 11m. P.M.; a transit egress of the satellite at 9h. 53m. P.M., and of its shadow at 10h. 6m. P.M. On the **29th** an eclipse reappearance of the third at 7h. 43m. 25s. P.M. On the **31st** an occultation disappearance of the first satellite at 9h. 58m. P.M.

Neptune is an evening star, rising on the **1st** at 2h. 11m. P.M., with a northern declination of 21° 15′, and an apparent diameter of 2·7″. On the **31st** he rises shortly after noon, with a northern declination of 21° 12′. During the month he describes a short direct path just to the south-east of ι Tauri. He will be in conjunction with the 6¼ magnitude star B.A.C. 1555 at about 2h. A.M. on the **19th**; 4½′ to the north of the star. A map of the stars near his path will be found in the *English Mechanic* for August 16th, 1895.

January is a favourable month for shooting stars, the most noted shower being that of the *Quadrantids*, the radiant point being in R.A. 19h. 12m., and 53° north declination; the greatest display being visible during the morning hours of **January 1st** to **3rd**.

The Moon enters her last quarter at 3h. 25m. P.M. on the **7th**; is new at 10h. 19m. P.M. on the **14th**; enters her first quarter at 2h. 42m. A.M. on the **23rd**; and is full at 8h. 55m. A.M. on the **30th**. She is in perigee at 4h. A.M. on the **4th**, and in apogee at 5h. A.M. on the **20th**.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 12th of each month.

Solutions of December Problems.

No. 1.—(A. C. Challenger.)

Key-move.—1. P to Kt5.

If 1. . . . R × P (Kt4), 2. B × Ktch, &c.
1. . . . R elsewhere, 2. Q × Pch.
1. . . . B × P, 2. Q to B4ch.
1. . . . Kt moves, 2. Kt to K3ch.
1. . . . P × Kt, 2. Q to Q4ch.

CORRECT SOLUTIONS received from G. A. F. (Brentwood), W. Willby, J. T. Blakemore, and A. H. Walker.

No. 2.—(A. G. Fellows.)

Author's Key.—1. Q to Qsq.

This problem, which was received too late for examination, appears to admit of *four* other solutions, viz :—1. R to QBsq, 1. Kt to Q3, 1. Kt to Q7, and 1. Q to Kt4.

CORRECT SOLUTIONS received from J. T. Blakemore (4 Solutions), G. A. F. (Brentwood) (2 Solutions), W. Willby, H. S. Brandreth, Alpha (2 Solutions), J. Lamond, W. W. Strickland, and A. H. Walker.

W. Willby and *G. A. F.*—Quite right as to the dual; but in the presence of the graver defects it may pass unnoticed.

J. W. R. Watson.—If 1. Kt to B7ch, K to B4.

Alpha.—Q to B6ch will not solve the sui-mate. After 1. . . . P × Q, 2. Kt to K3ch, K to Q5ch, the Knight can cover. Your solution could not be acknowledged last month. This page had gone to press some days before it arrived.

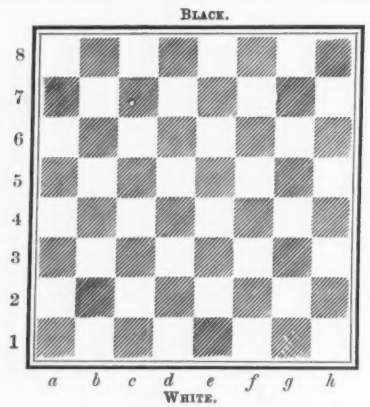
A Norseman.—It is too late now to "ignore" your correct solution to November problem (No. 2). At the same time we place on record your protest against the appearance of a problem with a capture for the key-move simultaneously with our remarks on problems of this nature. It should be observed, however, that the Pawn captured was not a movable one.

J. T. Blakemore.—Thanks for the problem. We will examine it, and hope to insert it next month.

THE EIGHT QUEENS PROBLEM.

Probably most Chess-Players are aware that it is possible to place eight Queens on a Chess-Board in such a manner that no Queen can play to a square occupied by any other Queen; but, possibly, some may be surprised to learn that there are ninety-two ways of performing the feat, and may be ignorant of the laws which connect the various methods, and of certain curious coincidences revealed by a study of the positions. At the present season such an examination may prove interesting, if not entirely profitable; and we shall begin by a simple enumeration of the ninety-two possible positions, reserving our remarks on them for a future occasion. We have divided the positions into four classes (A, B, C, D,) according to the position of the Queen on the Queen's Rook's file, and labelled each position with a Greek letter. In many cases the same letter is used. When this occurs it will be found that the positions are rendered identical when the board is turned round. We have used the German form of notation, and give a diagram to explain it. [QR3 is a3; KKt5 is g5, and so on.]

XUM

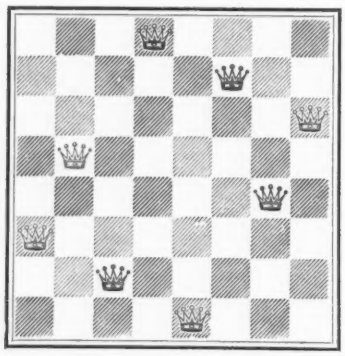


Here, then, are the positions, which anyone who works methodically can discover for himself in an hour or two.

A.—A1, *b5*, c8, d6, e3, f7, g2, h4. (α)
b6, c8, d3, e7, f4, g2, h5. (β)
b7, c4, d6, e8, f2, g5, h3. (β)
c5, d8, e2, f4, g6, h3. (α)

B.—A2, *b4*, c6, d8, e3, f1, g7, h5. (λ)
b5, c7, d1, e3, f8, g6, h4. (ζ)
d4, e1, f8, g6, h3. (η)
b6, c1, d7, e4, f8, g3, h5. (δ)
c8, d3, e1, f4, g7, h5. (κ)
b7, c3, d6, e8, f5, g1, h4. (γ)
c5, d8, e1, f4, g6, h3. (θ)
b8, c6, d1, e3, f5, g7, h4. (γ)

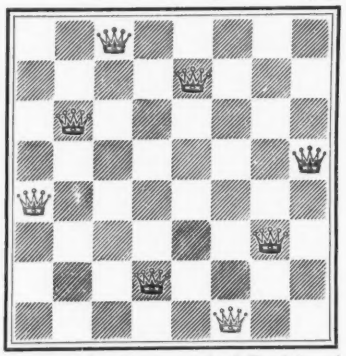
C.—A3, *b1*, c7, d5, e8, f2, g4, h6. (δ)
b5, c2, d8, e1, f7, g4, h6. (ω_1)



[Diagram of the symmetrical position (ω_1).]

e6, f4, g7, h1. (β)
c7, d1, e4, f2, g8, h6. (δ)
c8, d4, e1, f7, g2, h6. (ι)
b6, c2, d5, e8, f1, g7, h4. (ϵ)
d7, e1, f4, g8, h5. (ζ)
e5, f1, g8, h4. (η)
c4, d1, *e8*, *f5*, *g7*, h2. (θ)
d2, *e8*, *f5*, *g7*, h1. (α)
c8, d1, e4, f7, g5, h2. (η)
e5, f7, g2, h4. (ϵ)
d2, e4, f1, g7, h5. (ι)
b7, c2, d8, e5, f1, g4, h6. (ι)
e6, f4, g1, h5. (κ)
b8, c5, d7, e1, f6, g2, h5. (λ)

D. A4, *b1*, c5, d8, e2, f7, g3, h6. (ζ)
c5, *d8*, *e6*, f3, g7, h2. (γ)
b2, *c5*, *d8*, *e6*, f1, g3, h7. (κ)
c7, d3, e6, f8, *g1*, *h5*. (θ)
g5, *h1*. (α)
d5, e1, f8, g6, h3. (ϵ)
c8, d5, e7, f1, g3, h6. (ι)
d6, e1, f3, g5, h7. (λ)
b6, c1, d5, e2, f8, g3, h7. (δ)
c8, d2, e7, f1, g3, h5. (ω_2)



[Diagram of the Symmetrical Position (ω_2).]

d3, e1, f7, g5, h2. (ζ)
b7, c1, d8, e5, f2, g6, h3. (ϵ)
c3, d8, e2, f5, g1, h6. (λ)
c5, d2, e6, f1, g3, h8. (β)
d3, e1, f6, g8, h2. (γ)
b8, c1, d3, e6, f2, g7, h5. (θ)
d5, e7, f2, g6, h3. (η)
c5, d1, e3, f7, g2, h6. (κ)

These are evidently half the possible positions, which must be ninety-two in number. Any position beginning with A5 must be practically the same as one beginning with A4. So A6 is akin to A3, A7 to A2, and A8 to A1.

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TWO PLATES.—1, The Golden Eagle's Eyrie, with young and prey; 2, Photograph of the Nebulosities surrounding the Pleiades.

NOTICES.

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